DECEMBER, 1934

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METALS & ALLOYS

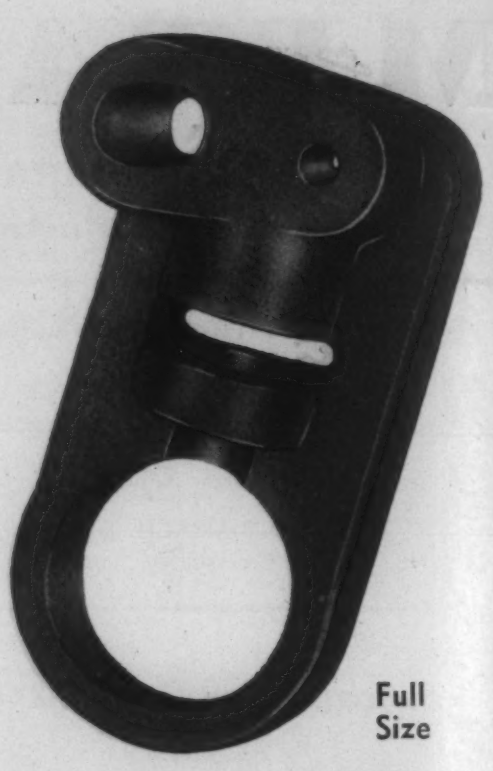
The Magazine of Metallurgical Engineering

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

Current Metallurgical Abstracts

The Result of a Proper Technique —

STRONGER-THAN-STEEL Die Castings are the result of the development of a proper technique for the production of aluminum bronze parts on a commercial basis—a development that has made available to modern industry that valuable combination of desirable properties for which aluminum bronze has long been known. Prior to the introduction of STRONGER-THAN-STEEL parts, however, the extensive use of aluminum bronze in industry was retarded by the difficulty of preventing the inclusion, in the alloy, of aluminum oxide, an impurity which causes a lack of uniform dependability in its behavior.



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HIGHLIGHTS

by H. W. GILLETT

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Sponge Iron for Steel Making

Sponge iron advocates have often claimed that sponge iron as a raw material for steel making was good for what ailed steel because of its freedom from nitrogen. Now come Barrett and Wood (page MA 555 R 1) to show that sponge iron is higher in N than usual steels.

Aluminum Conductor Cable

Augustin (page MA 590 L 1) claims that aluminum is O. K. as a material for conductor cable, even in corrosion resistance and that all its faults are due to the way it is put up, on the basis of 16 years of German experience.

Do Not Use Scrap Copper

Thews (page MA 558 L 1) says the way to use copper, brass and bronze scrap in the foundry is not to use it, but to refine it into secondary ingot and use that.

Acid Resistant Bronze

Giessereipraxis (page MA 557 L 8) mentions an acid resistant phosphor-bronze with over 2½% Sb. It has to be cast in dry sand to avoid porosity and hot to avoid cracking.

High Purity Iron

According to Turner (page MA 565 L 4), high purity iron can't be made by hydrogen reduction if the container has SiO_2 in its make up, since Si contamination ensues.

Get Yourself a Little Ingot

Dettmar (page MA 566 R 7) suggests a new use for iron as a heat storage medium in house heating or in drying equipment.

A Furnace What Am a Furnace

According to *Iron & Coal Trades Review* (page MA 568 R 3) German producers are making an 8 ton, 300 cycle high frequency steel furnace.

Blisterless Scale

In order to produce an iron oxide scale that doesn't blister, Griffiths (page MA 586 R 1) advocates adding water vapor to the oxidizing furnace atmosphere.

Phosphate Coatings

Rackwitz (page MA 587 L 1) discusses the history and the patent literature of phosphate coatings for rust prevention on ferrous materials.

Tin Plate

Teitz and 3 other Russians (page MA 559 R 8) conclude that surface roughness on sheet for tin plate is wholly due to improper rimming, so that blowholes in the ingot are improperly located. Overheating of the sheet bar accentuates the trouble. Russia's yield of primitive plate is only some 16% from the sheet bar.

Aircraft

A review of the work of the Bureau of Standards since 1925 on the causes for and the prevention of intercrystalline embrittlement of duralumin is given by W. Mutchler (page MA 587 R 1).

Cobalt in High Speed Steel

According to Yamaguchi (page MA 560 R 1) even common high speed steel in Japan contains 0.8% Co.

Know How!

We can remember when the early experiments on chromium plating of cutting tools were classed as rank failures even by those who had suggested it, and the proposal to try chromium plating of gages was vetoed by a military official supposed to know most about the gage problem. Now Chamberland (page MA 560 R 8) reports 300-600% improvement in many types of tools and 500-1000% on gages, by Cr plating. Know-how and pertinacity bring success.

Aluminum from Clay?

According to Floe (page MA 555 L 5), production of Al from clay is "feasible," and probably will compare favorably in cost with present methods of manufacture from bauxite. In view of the disastrous economic results of trials so far this seems a bold if not a rash prophesy. Why not have the TVA amuse themselves with this problem? If they do, we hope they start on a small scale so that only a few more government millions will be scattered to the winds.

Calcium Silicon Alloys

Calcium silicon alloys, says Weiner (page MA 555 L 6) are best made by using calcium carbide as reducing agent.

How Do the Tools Work?

According to Gottschalk and Doan (page MA 555 L 2) you can reduce the iron-tungsten ore ferberite to metal with hydrogen or natural gas instead of smelting it to ferro-tungsten and make high speed steel with it that analyzes all right. One would feel more comfortable about it if he also knew that the unreduced impurities in the ore were harmless and that the tools behaved right in cutting.

Chromium Plating

Dobrovsky (page MA 572 L 2) reports a kind of "spotting out" on Cr plated deposits, which difficulty was removed when the object was wetted before placing in the bath.

Selenium Plate

At a chemical meeting in London it was stated (page MA 573 R 6) that a thin coating of selenium on metals was a better protection against salt spray than any paint tried.

Cast Iron Grate Bars

According to Zeh and Piwowarsky (page MA 584 R 2) Ni, Cr and Mo are no help in low carbon (under 2.7%) cast iron for grate bars, but a great help in that of 3.3% C.

18-8 vs. Lower Alloy Steels

Friedewald (page MA 584 R 4) says that German steam plants don't think much of 18-8 for superheater tubes and are installing lower alloy steels instead.

Endurance Testing

Two sets of English investigators (page MA 577 L 1-4) describe new methods of endurance testing applicable to hard drawn or patented steel wire. In these high strength materials the endurance limit is not as nearly predictable from static properties as in softer steels. Gill and Goodacre suggest that endurance properties at stresses above the endurance limit are of importance.

No Laps

Sykes and Bampfylde (page MA 582 L 1) find that laps can be prevented in ingots of steels high in Al if the ingot mold is filled with carbon tetrachloride vapor.

Rapid Gaging of Wire

Schmid (page MA 574 R 4) utilizes a photoelectric cell to record the extent of the shadow cast by a very tiny wire passing continuously before it, and thus show any variation in diameter of the wire.

Magnification 30,000

A supermicroscope is described by Bennigson (page MA 578 R 1) and by Lutz (page MA 578 L 1) in which electron rays are used instead of light. Magnifications up to 14,000 have been obtained, and up to 30,000 is expected to be attained. Instead of lenses electrical coils are used for focusing, thus examination of metals at high temperature should be facilitated.

Die Casting

A few hundredths of one per cent impurity in die casting zinc is detrimental to corrosion resistance (page MA 574 R 2). High purity aluminum is necessary for good die casting. CSB.

SILK PURSES FROM SOWS' EARS

IT has been said that modern synthetic chemistry can make silk purses from sows' ears. *It can be done* by very smart chemists at a very high cost *but it isn't recommended as a means of making money.*

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EDITORIAL COMMENT

"What Good is a Test, Anyway?"

AN INTERESTING discussion among the committee members arose this fall at the meeting of the Metallurgical Advisory Committee to the Bureau of Standards. A report had been given on the study of the venerable red brass 85-5-5-5, in relation to the test bar type, pouring temperature and the individual or collective presence of impurities permitted by present specifications. As the study was based on the composition ranges of the specification, the usual static tensile tests laid down in the specifications had so far been employed.

The suggestion was made that other types of tests be employed as the work went on, since in some alloys hydraulic tightness shows an almost inverse relation to tensile strength. The discussion then touched on what lack of hydraulic tightness was due to. Of course, a hydraulic test shows up the leakers, but how is one going to find out whether the leakers come from something in the metal or from something avoidable in the melting, molding and casting procedures, and further, whether by varying either the composition or the procedure to match each other, the troubles cannot be avoided?

Dr. Johnston remarked that a test was merely an engineering convention and that it was not enough to know that a test was reproducible in the hands of various observers, but whether it really evaluated the property one wished to measure.

This brought out comment on the sodium cyanide etch test for revealing the free carbides in stainless steel, which, it was stated, gives results seldom interpreted alike by two observers and hence, as an acceptance test, it is classed by many commentators as a barrier to progress. The spiral casting for determining the castability of metals was mentioned (in regard to steel) as involving both the viscosity of the metal and its film-forming ability and a desire was expressed to have tests that would separate the two factors. Another member of the committee defended the test (for cast iron) on the ground that it does lump factors governing the ability of the metal to fill a mold, which is just what the test is aimed to show.

Still another commented on a case where, on the assumption that because some is good, a whole lot would be better, wire for wire rope was evaluated on the basis of the number of twists the individual wires would stand, but where, in fact, the maximum number is not the optimum number for the best quality for this particular service.

The subject may bear a bit of elaboration. Testing falls into two general categories—that done in course of production for the producer's information, and that performed on the final product for acceptance by the consumer. Meaningless or misleading tests of the first category seldom survive very long, but if a useless test of the second category is imposed, it may survive because a producer's objection to it is liable to be interpreted by the consumer as an attempt to force inferior goods past the barrier, and to strengthen his determination to impose that test.

Few tests actually measure the engineering property that is to be utilized. One can cite the yield strength for structural steel and the electrical conductivity for copper conductors as direct evaluations, but most generally the engineer really wants a set of properties that experience or reasoning tells him will be connoted rather than shown directly by conventional tests. We determine the hardness number when what we will really utilize is compressive strength, wear resistance, or something else we expect a hard material to have.

In the case of bearing metals, it is unlikely that any of the conventional tests on which such metals are specified directly measures any property required, and certainly there is as yet no yardstick for several properties that must be present.

We have often found it helpful to look at a test not as a test at all, but as a type of service and to consider that it evaluates materials for *that* service. With that attitude of mind one is less prone to assume that because A is better than B in that test service, it need be in other service, more likely to add other tests that evaluate factors arising in other services, less inclined to split hairs on tiny differences in test figures and more liable to stand off and view the sum total of the properties in relation to the exact use to which the material is to be put.

It isn't very helpful to know how to spell and pronounce a word in a foreign language unless we know how to translate it. And very often the usual and literal translation is so affected by the context that the word may have many different shades of meaning.

The phrase "the interpretation of a test" is an apt one. Too often the engineer who tests and the engineer who uses, each knows only his own language. The worst difficulty is that sometimes there is no word in either language for what the user really needs to express, and the specification imposed is merely a sort of sign language that something is wanted. When the user can stop pointing down his throat and tell the producer whether he needs a piece of apple pie or a tonsil operation, he'll come nearer getting the one he wants. He won't be charged for a fifty dollar operation when a nickel piece of pie is supplied, either.

H. W. GILLETT

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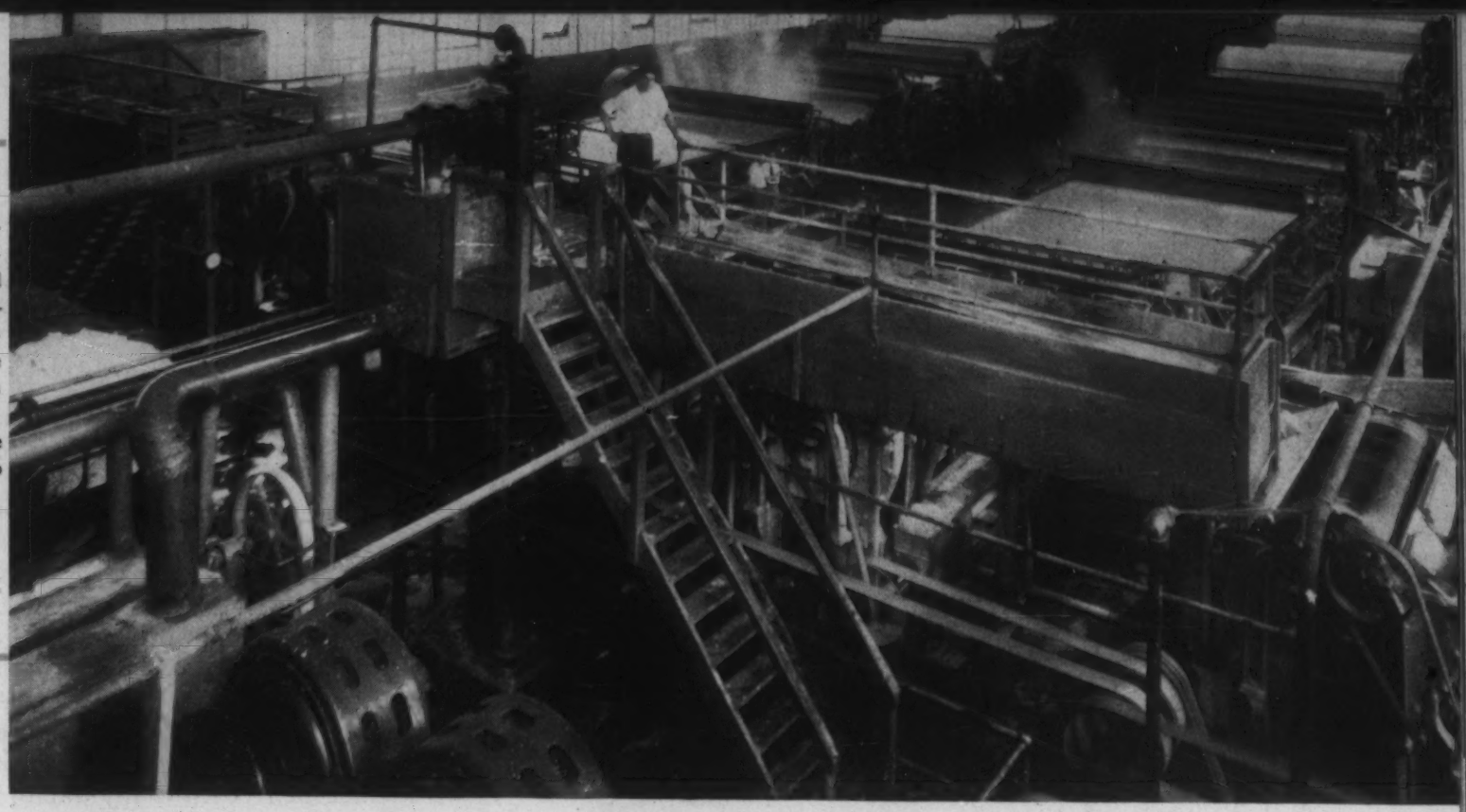

The paper machine is essentially a device for allowing carefully screened pulp of constant consistency to flow onto a horizontal wire screen, made in the form of an endless belt and traveling constantly away from the point where the pulp flows on it.

METALS and ALLOYS in the PULP and PAPER INDUSTRY

By J. D. MILLER*

A VARIETY OF METALS AND ALLOYS are in use in the pulp and paper industry. Application of these materials may be divided into two classes, those general uses which this industry has in common with most industrial plants and those inherent to this industry. To the first class belong common steel for sheet, rolled shapes, pipe and structural uses, power plant equipment and the common alloys as cast iron, brass and bronze.

This discussion will be confined to metals used for process equipment, covering in a general way the various unit operations and the metals which are in use to meet the particular service conditions of these operations.

Briefly, the major processes of the pulp and paper industry are the removal of the lignin from certain species of wood, thus liberating the cellulose content of the wood in various states of purity, depending on the pulping process, and the forming of this cellulose into a continuous web of paper. In the chemical processes, the soft woods, spruce, hemlock and balsam, are usually pulped by the acid or sulphite process and the hard woods and pines by either the soda or Kraft processes. It may be noted that the work of Dr. Herty at Savannah, Ga., may ultimately result in including the pines in the list of woods commercially amenable to sulphite pulping.

Regardless of the pulping process, the first step in wood preparation is chipping, whereby the wood is reduced to chip size to assist in the penetration of the cooking agent. This is done by rotating discs to which hardened steel knives are attached. The service is severe and the knives are removed for grinding after about four hours' service. Hard-facing alloys have been introduced for application to the cutting edges, with encouraging results. These alloys are also being used for chipper throats, building up worn pump shafts, as cutting edges for machine tools and various applications where hard abrasive wear is encountered.

The cooking reagent for sulphite pulping is a solution of calcium bisulphite containing an excess of sulphur dioxide, and is prepared by burning sulphur in rotary or spray type burners, cooling the gas in lead coolers, and passing the cooled gas into towers containing limestone or into milk of lime. Total sulphur dioxide in the acid at this point is about 3.5% and is increased to from 5 to 6% by relief gas from the digesters. The sulphur dioxide production and cooling is similar to that of the sulphuric acid industry, with the gas from the burner at from 800° to 1800° F. being conveyed to the cooler in cast iron pipe. Although the life of these pipe is relatively short, being about one year at the junction with the lead cooler pipes, alloy content cast iron of greater heat and corrosion resistance has not replaced the cheaper common cast iron. Cold cooking acid is handled in antimony lead pipe with acid-resistant bronze or chrome-nickel steel pumps and fittings.

A modern sulphite digester may be 15 ft. in diameter and 50 ft. high, of welded or riveted construction and may produce 20 tons of pulp per cook. To date the steel shell has been lined with silica brick, although the use of an alloy steel lining has been

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A view of the operating floor of the sulphate recovery plant, showing the connection between the smelter and rotary incinerator.

seriously suggested. Two methods of application have been proposed. The first is the welding of a thin sheet of alloy steel of about 1/64" thickness to the shell and all parts of the interior exposed to the cooking acid which will attain a temperature of about 300° F. at 80 lbs. pressure. Vessels for the oil industry have been constructed in this manner and successfully operated at higher pressures and temperatures. The second method is the use of a composite layer of alloy steel which is made an integral part of the common steel shell through an intermediate layer of pure iron. If the metallurgical problems involved can be satisfactorily handled on pots of the dimensions given, and the life be at least equal that of the silica brick, which is from 5 to 10 years, the pulp industry would benefit by avoiding the costly shutdowns for patching and relining, as well as obtain a greater productive capacity per digester by eliminating the thick brick lining.

In the direct method of cooking, steam is admitted into the digester after it has received the charge of acid and chips and the cover placed. To admit steam at the desired rate, it is necessary to relieve sulphur dioxide gas from the digester, and this gas at temperature up to maximum, saturated with water vapor and carrying some entrained organic matter, is cooled in water submerged lead pipe or alloy steel tubular coolers. The cooled relief gas is vented into the cooking acid storage tanks in usual practice.

Until a few years ago pipe for handling this hot relief was either extra heavy copper or brass, with fittings of acid-resisting bronze of 85 Cu-10 Sn-5 Pb. The excellent progress made by the metallurgical industry has resulted in the gradual elimination of all non-ferrous alloys from the hot end of the process and the substitution of Cr-Ni steel for all valves, fittings, thermometer wells, cover-liners, strainers, pipe or tubing and circulating pumps for circulating systems. In general, castings for this service conform to the specifications of the Technical Association of the Pulp and Paper Industry, which were drawn in coöperation with all the producers of these castings. Minimum values specified are 20% Cr-9% Ni, with carbon at 1/100 the Cr content and Mo optional up to 4%. Results obtained from this analysis have been generally good, particularly when all non-ferrous metals have been eliminated from the systems. Good results have been obtained from the marginal alloy 18-8 for pipe and tubing, although the tendency is to raise the alloy content to assure greater permanence.

It should be noted that these alloys have made possible the indirect cooking method, wherein the acid is circulated during the cook through a tubular heater constructed entirely of alloy steel. Advantages obtained include greater pulp uniformity, heat economy and better control of cooking by avoiding dilution of the cooking acid by the heating steam.

While results with these alloy steels have been generally good, their austenitic structure seems to make them sensitive to many factors during fabrication and installation. Due probably to one or more of these factors, often beyond control, castings or pipe with standard analysis and heat-treatment, will fail prematurely. This has led to the use to some extent of the non-austenitic steels, with Swedish practice tending to the 27% Cr - 4.5% Ni - 1.5% Mo analysis trade-named Avesta. This alloy as well as plain 27% Cr appear totally resistant in sulphite service and are reported as being particularly good in cases of high sulphur trioxide content of cooking acid, and are more readily machinable. Whether either or both of these alloys will prove more satisfactory in this country than the alloys now in service will depend on intensive trials in service.

The soda and sulphate pulping processes have no comparable problems as the alkaline cooking reagents permit the use of unlined digesters and iron or steel accessories.

At the completion of the sulphite cook, the blow valve is opened and the contents of the digester are blown into a tank with a perforated bottom to permit the waste acid to drain from the pulp and later to be thoroughly washed from the pulp by water. Perforated 18-8 sheets have replaced acid-proof tile or wood bottoms in practically all recent installations.

In a few instances, the waste acid is evaporated in copper evaporators or neutralized and evaporated in iron evaporators using charcoal iron tubes. As it comes from the digester, the waste acid contains about .5% sulphur dioxide and some organic acids. It is likely that an alloy steel could be used to replace copper to advantage when unneutralized acid is evaporated.

In the case of the soda and sulphate processes, the waste liquor is washed from the pulp in a battery of diffusers and evaporated to about 50% solids content.

It is essential that every trace of bark should be removed from wood that is to be used for making pulp. The bark colors the pulp and fills the paper with dirt specks.

In the causticizing tank lime is added to a solution of soda ash. The lime mud produced is thoroughly washed to remove all traces of caustic soda by repeated washing, settling and decantation until the sludge is as free from alkali as possible.

Iron tubes may be used, although Monel metal has been found to be more satisfactory for this service. After concentration, the so-called black liquor is burned to recover the sodium salts, which are then causticized by lime. The recovery furnace in which the concentrated liquor is burned constitutes the materials problem of these processes. Furnace linings are usually of soapstone or chrome brick, with service life of about one year. A promising start to the solution of this problem has been made. A water-jacketed steel smelter body which had been in continuous service for 18 months was reported as showing no indications of wear at the end of that period. An added feature was the production of hot water equivalent to 3,000 lbs. of steam per ton of pulp, which was available for pulp washing.

Since the above pulping processes use a reagent to remove the lignin from the wood, they are termed chemical processes, and the pulp chemical pulp. Ground wood pulp or mechanical pulp is produced in large tonnages as it constitutes 70%-80% of the fiber in news print, and is made by pressing bolts of wood against the surface of revolving sandstones or artificial stones, by hydraulic pressure. Usually no severe corrosion problem exists, although when the flushing water is recirculated, the organic acids may build up a concentration sufficient to produce a pH of as low as 4.4. In such cases 18-8 alloy steel has been found satisfactory to meet the condition for pumps and fittings.

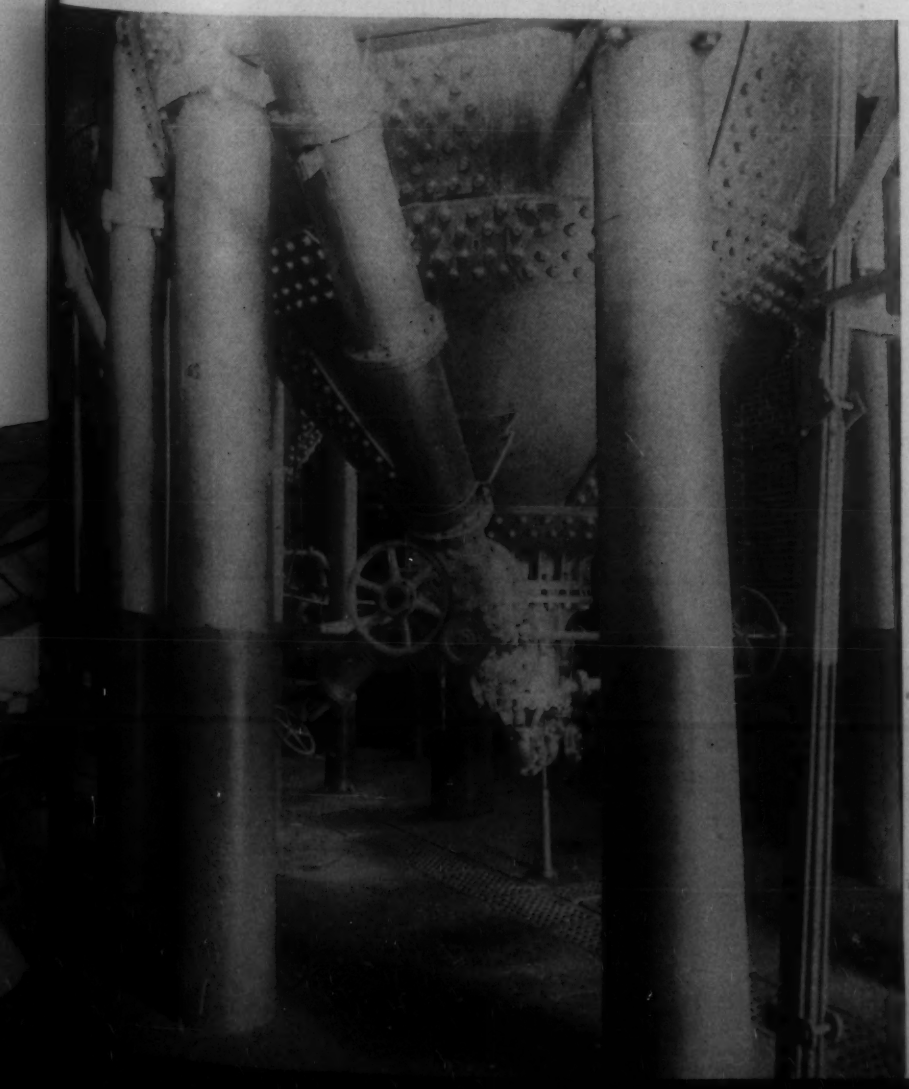
In all the pulping processes, it is necessary to remove slivers, knots and uncooked chips from the pulp. This is accomplished by rotary or flat screens. The replacement of the usual bronze screen plates by chromium plated plates has increased screening efficiency as that hard surface retains hole or slot dimensions and reduced the tendency for the screens to plug.

When it is desired to store mill produced pulp, this may be done by removing a part of the water from the pulp as it comes from the screens, and running the pulp to tanks or further drying on so-called wet machines which press the pulp to water content of about 65%, when the pulp may be handled in lap form. Water removal is done by screening the water suspension through a wire-covered cylinder, which revolves in a vat containing the stock. In cases of mills using wet machines, the cylinders are usually covered with worn or damaged Fourdrinier wires, although tests indicate that 18-8 wire is very suitable for the service if the backing wire is of the same material.

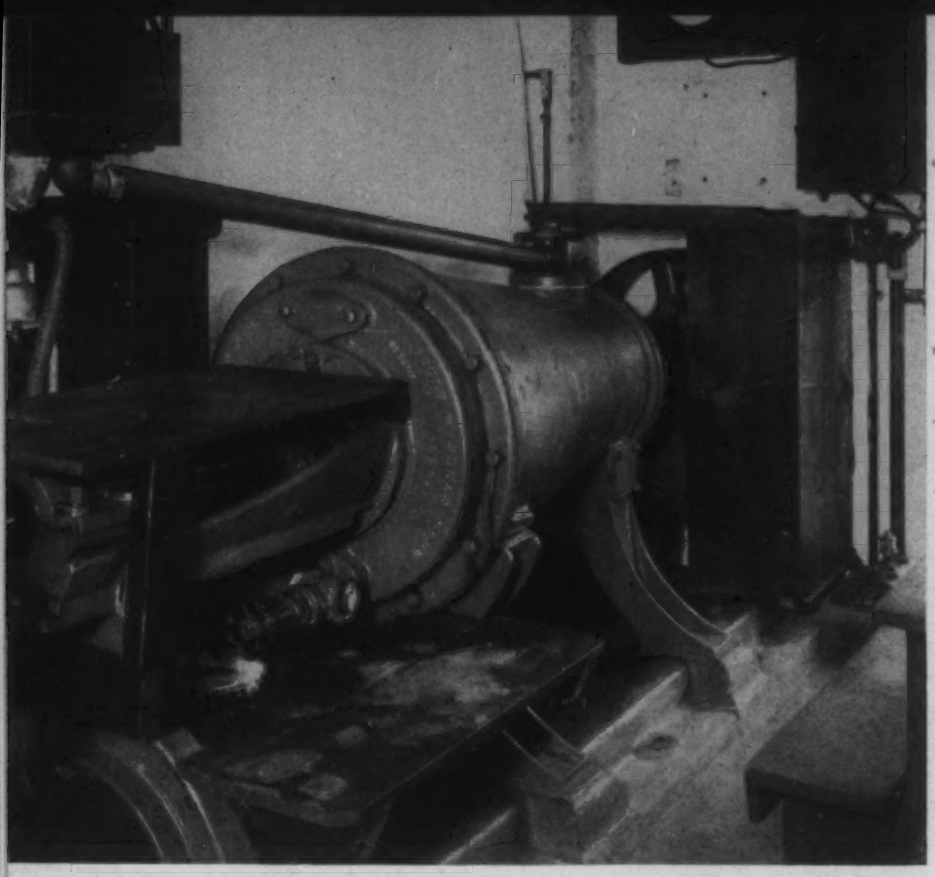
In the manufacture of white papers it is necessary to bleach the stock. This is accomplished by the use of bleach liquor usually prepared at the mill from liquid chlorine. Two stage bleach is finding favor, with a preliminary treatment of the pulp with a solution of chlorine, washing of the pulp to remove the materials affected by the chlorine, and finally giving the pulp a normal hypochlorite bleaching.

Chlorine solutions and bleach liquor are corrosive to metals and the use of metals is avoided when possible. Bleachers are lined with tile. When bleach lines are kept filled with solution, wrought iron and steel may be used. Chromium-nickel cast iron, or the high silicon iron alloys assure greater permanence for valves, fittings and accessories.

Of particular importance is the avoiding of iron contamination after the pulp has been bleached, and pipe lines for bleached stock are usually of wood, copper or other iron-free materials. Cement lined pipe has met with success in several instances. For



A view of the sulphite digesters, showing the blow lines and liquor and steam inlets.



The Jordan machine gives the paper-stuff the last refining touch before it goes to the paper machine. Each little bundle of fibers is separated and distributed throughout the material in such a manner as to make the whole stock consistent and homogeneous.

this service stainless steel should find application, although to avoid the cost handicap, it would probably be necessary to resort to the thin sheet of alloy applied to common steel.

Before forming into the sheet of paper, it is necessary to mechanically brush out most of the cellulose fibers, thereby producing a frayed or fibrillated effect on the otherwise relatively smooth surface of the fibers. When frayed to the proper extent, the sheet will be of more uniform formation and greater strength than if not so treated, due to greater opportunity for the fibers to interlock during the formation of the sheet of paper.

This stock preparation is done in what are called beaters, in batches of from 1,000 to 2,000 lbs. of stock, in usual practice. Beaters are of several designs, with the most common being an elliptical tub of wood or cast iron, separated for about half the length of the tub by a partition called the mid-feather. The stock is caused to circulate around the mid-feather by a beater roll rotating on one side of the mid-feather and located at the middle of the tub. This beater roll is a cylinder of width equal to the space between the mid-feather and the wall of the tub, and provided with metal bars arranged on the periphery of the roll, similar to a paddle wheel. The roll rotates above a bed plate which contains similar bars, and the clearance between the roll and bed plate is adjustable by vertical motion of the roll. Beating is done from 20 minutes to 18 hours depending on the stock being treated.

While in the beater the stock is dyed if required and sized. The latter operation converts the water-absorbent cellulose to a more water-resistant material, and is accomplished by the addition of a solution of rosin size, which after being thoroughly mixed with the fibers is precipitated by the addition of aluminum sulphate. When the aluminum sulphate is added to the beater in solution, rubber, lead or Duriron equipment is used. Usually this precaution is avoided by addition of the sulphate in dry form.

Due to the acidity of aluminum sulphate solutions, the pH of the beater water may be as low as 4.2. This acidity together with the hard mechanical service due to close clearance between the beater roll and bed-plate introduces a problem of the best material for beater-bars and bed-plate. In handling bleached stock where iron contamination is to be avoided, bronze bars have been standard, but in recent years chrome steel of 14% Cr or 18 Cr-8 Ni steel have been meeting with favor, as the corrosion resistance is quite satisfactory and, being harder, resistance to mechanical wear is greater, thus reducing the costly bar replacement. For coarse papers common steel bars are frequently used.

A second step in stock refining in general use is Jordaning. The Jordan is a conical plug rotating in a conical shell, both lined lengthwise with bars, with the clearance between the plug and shell controlled by movement of the plug. This service is comparable to beater service, and the same materials are used.

With the stock suitably prepared for the particular grade of paper to be made, the next step is the formation of the sheet. In the case of board or very heavy cards, the thick sheet is formed on one or more cylinders covered with a screen of brass or bronze wire, each cylinder rotating in a vat containing the water suspension of the fibers. The separate wet sheets are subsequently pressed together and dried.

In the formation of paper other than board, the stock is run at about .5% consistency onto a continuous web of about 65 mesh wire, which permits a large part of the water to drain from the stock, thus forming the sheet. The interlacing of the fibers is encouraged by shaking the wire before the fiber concentration has become too high. When the concentration reaches a certain point, it is impossible for the fibers to change position in the wet sheet.

The Fourdrinier paper machine which is distinguished by this moving endless web of wire on which the sheet is formed, together with the accessory equipment, is an interesting item from the metallurgical viewpoint. Of greatest importance is the wire itself, which, due to its delicate structure and hard service, enters into the cost of manufacture of paper to the

Dried pulp leaving the dryer and being conveyed to the hopper ready for baling. After baling the pulp is ready for shipping.

extent of from 25 to 50 cents per ton of paper made. The magnitude of this cost may be appreciated when one considers that companies manufacturing 500 tons of paper per day are not uncommon.

This machine wire may be 100 ft. long and 300 inches wide and traveling at speeds up to 1,500 ft. per min. It is carried on a horizontal or sloping plane by table rolls during the time the stock suspension is on the wire. During one revolution of the wire it passes over suction boxes for further removal of water from the sheet, around the couch roll, which may be of the suction type or the old style solid roll, on which a second roll is riding, and after being carried on rolls to the head-box end of the Fourdrinier, will pass around the breast-roll to again receive the water suspension of stock. The high speed and repeated flexing of the wire, together with accidental denting account for the short life of the wires.

Although considerable research has been done on wires in Europe and this country, copper, brass and phosphor bronze continue to be the standard metals, with bronze usually used on the high-speed machines. So far the only real results from all the investigations have been improvements in seam formation and more uniform quality of wires of the different standard weaves due to closer control of metal quality and fabrication on the part of the wire manufacturers. When the unusual physical properties and corrosion resistance of the 18-8 alloy were being made known a few years ago, several wires were drawn and woven of this material. Naturally the repeated flexing of the wire caused brittleness and short life of the wire. They were not as good as the non-ferrous alloys and in no way approached the answer to the problem.

Certainly the problem is most inviting and although we have apparently made no great progress in the substitution of a better alloy for the work, it is hoped that in the future further research will uncover better alloys and better wires to the mutual benefit of the metallurgical industry and the paper industry. In this connection it may be recalled that the present quality of Cr-Ni steel castings for sulphite service is due to an extent to the splendid coöperation between the producers and consumers of these products. The two problems are not identical, but the experience in the one may serve as a guide for the future for the other.

A number of different alloys are used in the construction of a paper machine, particularly the Fourdrinier or wet end. Several metals have been used for table and wire carrying rolls, including rubber covered or bare aluminum, brass and stainless steel. The latter alloy is finding favor with the more progressive machine manufacturers as a substitute for wood for save-all vats, as the tendency for stock, slime and filler to accumulate is greatly reduced by the polished steel surfaces. Other applications of stainless steel are for slices, Fourdrinier and felt suction boxes. A steel box can be made twice as rigid and of half the weight of the old cast type non-ferrous boxes or even a box fabricated from non-ferrous sheets and shapes.

Stainless steel, due to its hardness and toughness also makes good suction-box covers and is being used in large quantities for various other small parts as cap screws, bolts, nuts and ties that pass across the machine and are subject to corrosion. It is being experimented with for use in anti-friction bearings, and one of the most progressive manufacturers has expressed himself as looking forward to a continuous advance in the use of stainless steel on various parts of the paper machine, including some parts for the dry end where corrosion resistance is not a factor.

THE METALLURGICAL REQUIREMENTS of industries which we ordinarily think of themselves as mechanical, chemical, or anything but metallurgical, may nevertheless be extensive and vital. The needs are generally quite specialized, and suitability for these needs is not to be evaluated on the mere basis of strength and ductility.

In the more progressive of such industries much of the advance in materials is due to the search of the ultimate user, who knows the details of the service, for better materials to match that service, at least as much as to the sales effort of producers who see possible new markets for special alloys.

While the paper industry is not lacking in metallurgical contacts already, it still has problems which lack fully adequate solutions. We hope that the publication of this brief but clear glimpse of such problems will incite more metallurgists to study them and provide still better solutions.

Chromium plating has had quite wide application in the industry as the more durable wearing surfaces reduce maintenance costs and frequently improve manufacturing processes. Plating for Fourdrinier suction box covers, press felt suction box covers, creping doctors and calender rolls are typical examples, aside from screen plates previously mentioned.

Nitrided steel offers possibilities for application on a paper machine. With a case hardening effect approaching diamond hardness and an apparent total resistance to paper making chemicals, the material when highly polished may be used for suction box covers and other parts where abrasion resistance and chemical inertness are essential. Nitriding of ordinary steel bolts makes them corrosion resistant at a cost considerably lower than stainless steel.

If one were to try to anticipate the paper machine of the future, it would probably lead to a machine constructed largely of stainless materials, and possessing operating characteristics superior and more permanent than the machine of today.

Processing subsequent to the formation of the sheet and mechanical removal of water include drying of the wet sheet on a series of steam heated dryers, which are usually plain cast-iron, and finishing on calender stacks, if necessary. Usually calender rolls are plain cast-iron also, with chill hardened surfaces. Better strength and surface properties can probably be had by the use of an alloy cast iron as one of the nickel irons. Such a base metal with chromium plate if desired should be a marked improvement over the common cast iron for both calender rolls and dryers.

This discussion has covered in a general way some of the major applications of metals in the paper industry. Certainly these new products of the metallurgical industry are most welcome. It may be safely predicted that new equipment in the future will be utilizing these new materials to the fullest extent.

Bonding Strength of Babbitt to Steel and Bronze*

By E. G. Soash

Extended Abstract by H. W. Gillett

LARGE crank pin and cross head bearings of 182 and 120 in.^{2} projected area operating at 1200 and 1900 lbs/in.^{2} maximum bearing pressure on the low pressure side of compressors operating at 120 r.p.m. (driven by 2000 h.p. motors) where there is reversal of motion, are subject to very severe service. The bearings are lined with ¼ in. of babbitt of 83% Sn, 9½% Cu, 7½% Sb, and gave trouble by the lining squeezing out and cracking in spite of improvements in location of oil grooves, use of hardened cross head pins, increase in oil feed, etc., and it was decided that the cause of the trouble lay in poor bond between steel bearing back and babbitt lining.

An investigation of variables in bonding was undertaken in which ⅝" steel bolts with heads machined flat and to ⅝" square were placed in line with the heads ¼" apart in a jig, and the babbitt poured between the heads. Similar bolts were machined from various bronzes, in which case the heads were ½" square. The specimens were filed free from babbitt that had flowed over the bolt head, and pulled in tension.

Variables in the cleaning, tinning and babitting of the bolt heads were studied. Sandblasting the steel bolts was found inferior to machining, as it left silica dust embedded in the surface, and the blast was liable to carry oil from the compresser, which left a film after the oil burned off in the tinning bath. Sandblasted surfaces must be cleaned. Without cleaning the babbitted specimen would often come apart on taking from the jig.

The following procedure, clean with hot caustic soda solution, wash, brush with $CuSO_4$ solution to give a coating of cement copper, wash, brush with 10% NH_4OH, wash, brush again with $CuSO_4$, wash, then heat, flux with $ZnCl_2$ solution, tin dip and brush with $ZnCl_2$, was not found efficacious, as it was difficult to keep the cement copper plating thin and adherent. In all specimens so treated, the babbitt pulled away from the steel. The method was discarded and pickling tried.

Pickling with HCl gave a clean surface, but one whose metallic lustre was soon lost, probably by oxidation. Specimens HCl pickled broke at about 6000 lbs./in.^{2} average. Cleaning in hot NaOH solution (3 lbs./gal.) gave best results, specimens averaging 7000 lbs./in.^{2} or over. From this point on, fluxing, tinning and babitting were best carried on in about the customary manner, but with great attention to detail. The specimens were preheated in the tin or solder bath for 5 minutes, fluxed in $ZnCl_2$, NH_4Cl solution (satisfactory fluxes can be made from 2½ lbs. Zn, 1 gal. HCl or by using a dry mixture of 8½% NH_4Cl, 91½% $ZnCl_2$ in the proportion of one volume of this mix to three volumes of water), with vigorous wire brushing tinned 15 minutes (for steel, 5 to 10 minutes for bronze), the tinned surface brushed with the flux and babbitt poured within one minute after removal from the tin bath.

No appreciable difference in strength was found whether the tinning bath was pure Sn or 50 Sn, 50 Pb if the former was operated at 300-350°C. and the latter at 250°-300°C. If the pure Sn bath was operated hotter, the coating had to be cooled to about 300°C. and fluxed to remove the oxide formed at the higher temperature. The 50:50 solder was preferred on a cost basis and 300°C considered the most practical operating temperature.

Leaving the sample in the solder bath 15 minutes and keeping some $ZnCl_2$ flux on top of the bath to prevent drossing were considered important, as was re-fluxing of the tinned (either Sn or solder) surface before pouring the babbitt. Omitting the fluxing after tinning was one of the surest ways of getting a poor bond. Any excess of Sn or solder should be wiped off before babbitting, as it is weaker than the babbitt.

Babbitting as quickly as possible after tinning, so that the tinned surface is bright, is highly important, and one of the chief keys to success.

Depending on the degree of cleanness of the steel surface when the tinning layer was applied and on that of that layer when the babbitt was applied, the strength of the joint ran from zero to about 9800 lbs./in.^{2} with an average, when using the procedure finally chosen, of 7000 lbs./in.^{2} or better.

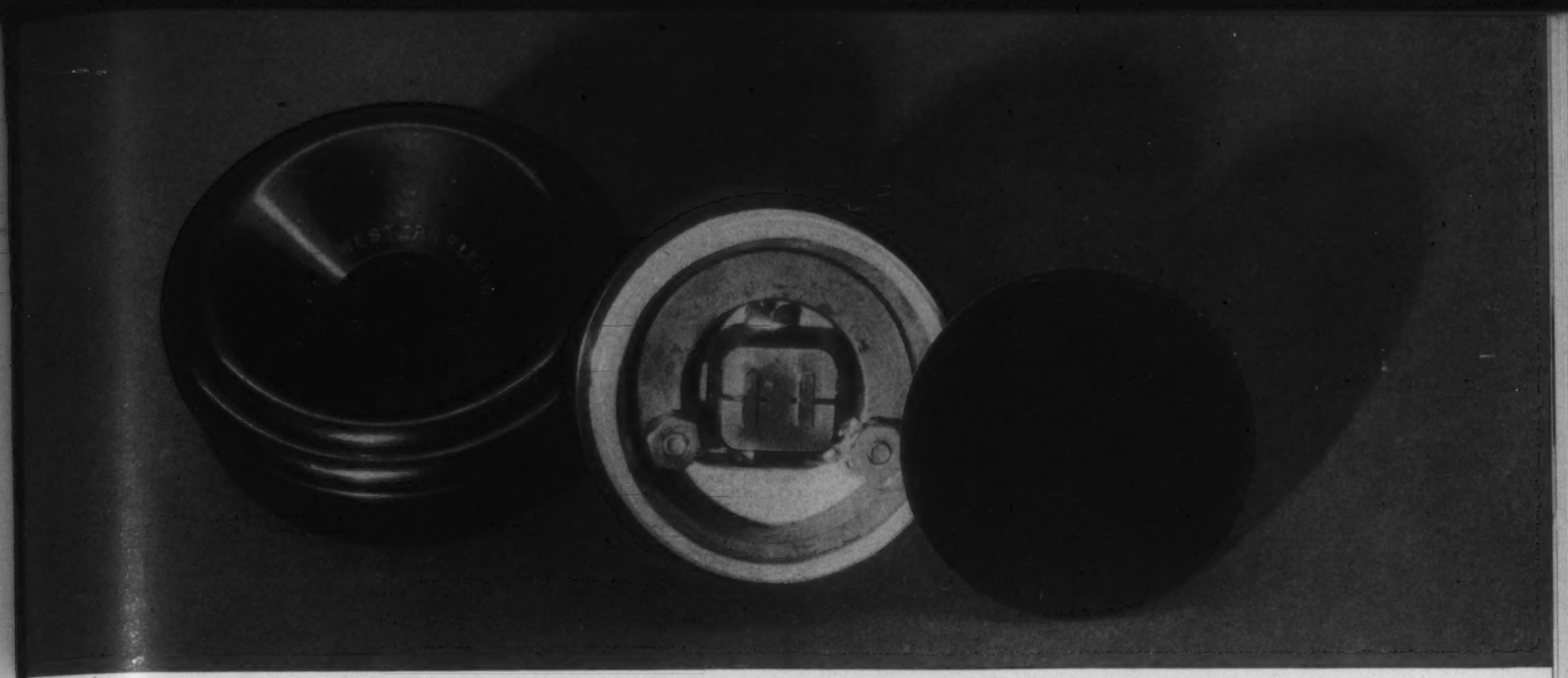
Bronze specimens fluxed with $ZnCl_2$ and tinned with 50 Sn, 50 Pb, using the precautions mentioned above, usually gave about 13000 lbs./in.^{2}, though one lot of bronze would not tin well, and gave low values, and Everdur gave no better results than steel.

The superior bonding of babbitt to bronze made it desirable to use bronze instead of steel backs for bearings of the compressor connecting rods. After this substitution, and fluxing, tinning and babbitting by the procedure indicated by the tests, the bronze-backed bearings (made from 88% Cu, 7% Sn, 3% Zn and 2% Pb) had, at the time of writing the report, given over 6000 hours operation without any cracking away of the babbitt, which had occurred in a few days with the steel-backed bearing babbitted with less attention to securing good adherence. Information from Mr. Soash at the time of preparing this abstract, records the period of satisfactory operation on three hypercompressors as 7000, 9000 and 9000 hrs. with the bearings still in service without signs of deterioration.

* Thesis for Mechanical Engineering, Ohio State University, 1934. Not published, available at Ohio State University library upon written authorization of the author, c/o E. I. du Pont de Nemours & Co., P. O. Box 1537, Charleston, W. Va. 46 typed pages.

Harbison-Walker Acquires Goldschmidt Forsterite Patents

The Harbison-Walker Refractories Company has announced the acquisition of the American rights to the forsterite patents of Goldschmidt and his associates through an exclusive royalty granted by Dr. Victor M. Goldschmidt of Göttingen, Germany. These patents cover refractories made of olivine and of the other magnesium silicates. Included in the group are more than a dozen United States and Canadian patents. Forsterite has a melting point of 1910° C. (3490° F.). It is the only magnesium silicate which will remain stable at the temperature at which many industrial furnaces operate. Forsterite has the chemical formula 2 MgO: SiO_2 and is the principal constituent of the more refractory olivines.



In the receiver for the Bell System handset the horseshoe shaped permanent magnet is of cobalt steel and the pole pieces are of silicon steel. The diaphragm is of low-carbon iron.

MAGNETIC MATERIALS

A Survey in Relation to Structure

By W. C. Ellis* and Earle E. Schumacher*

Introduction

MAGNETIC MATERIALS may be classified according to properties into two groups: 1. soft magnetic materials, and 2. hard or permanent magnet materials. The differences in properties of the two groups are illustrated in Fig. 1, which shows typical magnetization cycles for the two types. The dashed line is a normal magnetization curve while the closed full line is known as the hysteresis loop.

A soft magnetic material is, in general, characterized by a steeply ascending magnetization curve; that is, large values of flux density are produced by small magnetizing forces. For certain applications where the flux density is low, the initial portion of the curve is important. For intermediate flux density applications the steeply ascending portion is of paramount interest, while for higher densities, the upper portion is of prime importance.

Another term which is widely used in discussing soft magnetic materials is permeability. The permeability at a given flux density is the slope of the straight line joining that point on the magnetization curve with the origin. Algebraically, it is the ratio of the flux density, B, to the magnetizing force, H. It depends upon the flux density, and for soft magnetic materials at low magnetizing forces, is a large quantity. The permeabilities usually reported in discussing magnetic properties are the initial permeability, μ_o, and the maximum permeability, μ_{max}. The initial permeability is the initial slope of the magnetization curve at very small values of H. The maximum permeability is the maximum value that the ratio, B/H, attains.

Hysteresis is also of importance, especially in alternating current applications. The phenomenon of magnetic hysteresis results in a loss of energy in a magnetic material when the material is carried through a magnetization cycle. The loss of energy is proportional to the area of the hysteresis loop. In soft magnetic materials, the aim, in practically all cases, is to keep this loss a minimum.

A hard or permanent magnet material is characterized by a gradually ascending magnetization curve; that is, the material at all magnetizing forces has a relatively low permeability. To attain practical saturation is difficult, requiring in some alloys magnetizing forces of thousands of oersteds. The important properties are associated with the demagnetization curve, that portion of the hysteresis loop between points (1) and (2) in Fig. 1. In general, the hysteresis loop in its entirety is of little importance. The constants usually determined in permanent magnet investigation are the residual induction, B_r, and the coercive force, H_c. The product of these 2 quantities (B_rH_c), which is roughly proportional to $(BH)_{max.}$ on the demagnetization curve, has been considered by some[1] as a quality index for permanent magnet materials.

Summarizing the general properties of soft and of hard magnetic materials, in the former, high maximum permeability is associated with low coercive force and a hysteresis loop of small area. In the latter, a low permeability is associated with a high coercive force and a large hysteresis loop. The range of properties which can be obtained in magnetic materials by alloying and other metallurgical control is most remarkable. Permeabilities from 1 to over 600,000 and coercive forces from 0.012 to 600 oersteds, are attainable.

In manufacturing soft magnetic materials, the metallurgist strives constantly to eliminate those elements (impurities) which broaden the hysteresis loop, while in the case of the permanent magnet materials, he intentionally adds certain of the same, or other elements, and resorts to heat treatments which broaden the loop. Some details of these procedures with well known materials, and also with some more recently developed, are described in the following pages.

* Bell Telephone Laboratories, Inc.

Magnetic Iron

Of the ferromagnetic elements iron, nickel, and cobalt, iron, at the present time, is the only one of industrial importance as a soft magnetic material in the unalloyed condition. Throughout the last half century, a continual improvement in the magnetic quality of iron has been effected, until at present, laboratory samples have been prepared with permeabilities[2,11] of over 200,000. Careful analysis of the data shows that this improvement has paralleled closely increases in the purity of the iron.

Since the production of iron of high magnetic quality is of considerable interest at this time, it seems worth while to examine in some detail, the methods which have been used for producing high purity iron. Methods which have been developed for the purification of iron, have, in each instance, removed from the iron, elements (impurities) which are harmful to easy magnetization.

The elements which enter into iron as impurities may be grouped, structurally, into 2 classes: substitutional elements, and interstitial elements. The substitutional elements exist in the iron structure at lattice points; that is, they substitute for iron atoms in the lattice. These elements include most of the metals, for example: nickel, cobalt, manganese and silicon. The interstitial elements enter into the iron lattice at intermediate points; that is, they take positions in the structure between the iron atoms. Elements included in this classification are carbon, oxygen, and nitrogen. It is these latter elements which, although present in small quantities, cause severe strains in the lattice, and are believed, on this account, to be particularly harmful to the magnetic softness.

The solubilities of the interstitial elements at room temperature have been determined by a number of investigators. The most reliable values, which, because of the difficulties involved, probably should be considered tentative, place the room temperature solubility of carbon at approximately 0.008%[3]; the solubility of oxygen at 0.01%[4]; of nitrogen at 0.015%[5]; and of sulphur at 0.015%[6].

The solubilities of the interstitial elements vary with the temperature, increasing, in general, at higher temperatures. Varying solubility provides the possibility of precipitation hardening, which, in the case of iron, results in magnetic hardening. It is this latter type of hardening to which the magnetic aging of iron is attributed. This is possible because the supersaturated phase will in most of these systems precipitate the interstitial element at room temperature in a form which produces severe strains with deleterious effects on magnetic softness. Because of their harmful effects, the purification of iron for soft magnetic purposes has been in the direction of eliminating these interstitial elements. The 3 methods of purification which have been used are illustrated in the chart shown in Fig. 2.

The earliest method used was the addition in the molten state of a substitutional element which diminishes the harmful effect of interstitial elements in the iron lattice. Silicon* is an element beneficial in this respect. Its action may be explained by postulating that its presence decreases the solubility of carbon in iron. The silicon enters the iron lattice as a substitutional element, and as such, is less harmful to the magnetic softness than the interstitial element, carbon, which is removed. Since silicon is also a strong deoxidizer, it will remove oxygen from the iron. These reactions do not completely eliminate the carbon and oxygen, and consequently, although a noticeable increase in magnetic softness is obtained, the high values of permeability achieved with the more efficient methods of purification are not reached. The improvement attained by this treatment is illustrated in Fig. 3 by comparison of typical magnetization curves for Armco iron[17] and for a commercial 4% silicon steel.[8]

The second method of producing a purer iron consists of eliminating some of the harmful elements by melting in a high vacuum.[9] Under these conditions, the residual carbon and oxygen in the iron will combine to form carbon monoxide, which is removed by the exhausting pumps. At the same time, due to the dissociation of the nitrides at the high temperature, the nitrogen is similarly removed. Again, the reactions do not go to completion, and residual impurities remain. Another obvious disadvantage is the fact that it would be only accidental if oxygen and carbon were present in the iron in the right proportions to eliminate one another. If the oxygen and carbon contents of the raw materials are known, adjustments can theoretically be made by adding either carbon or iron oxide, but if such a process is in commercial operation, the writers are not aware of it.

Yensen[9] reports a laboratory experiment in which this method of purification was used. A number of samples were prepared in high vacuum from electrolytic iron. To successive samples, increasing amounts of carbon were added to a maximum of 0.5%. The maximum permeability increased with additions of carbon from approximately 25,000 for the sample with no addition to a maximum of 61,000 for a 0.06% addition. From this value, the permeability dropped rapidly with further additions of carbon. The maximum value of 61,000 is explained as due to the fortuitous coincidence that the correct amounts of carbon and oxygen were present for optimum elimination.

Vacuum melting and vacuum purification present some interesting possibilities in connection with the preparation of magnetic materials. Commercial vacuum melting has been developed in Germany at the Heraeus plant,[10] where furnaces with capacities of 5 tons are in operation. It is stated that capacities of 20 to 30 tons can be achieved without large departures from the present designs. Vacuum melted metal is mechanically softer and works more readily than metal prepared by ordinary melting procedures. For magnetic alloys, the combination of vacuum melting and casting provides facilities for preparing material without contamination by the atmosphere. There seems to be no reason why one cannot go further and actually carry on refining operations in the furnace. The future of vacuum melting and casting appears extremely rich in possibilities, particularly for producing magnetic alloys where high purity is a primary consideration.

The third method of purification of iron is by treatment with an element which reacts with the interstitial elements to form gases which are removed. Hydrogen has been used for this purpose by Cioffi,[11] and the method has been described recently. The treatment is carried out at high temperatures between 1300° C. and the melting point of iron. Cioffi states that ordinary amounts of carbon, oxygen, nitrogen, sulphur and phosphorus are reduced to very small quantities by hydrogen treatment. The excess hydro-

* Messrs. Barrett, Brown & Hadfield[7] reported the magnetic properties of iron-silicon alloys in 1900. More recent studies have been reported by Yensen.[9]

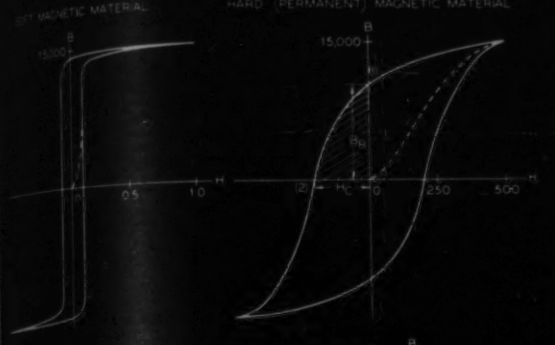


Fig. 1. Schematic Representation Comparing Characteristics of Soft and Permanent Magnet Materials.

Fig. 2. Schematic Representation of Methods of Purifying Iron for Magnetic Purposes.

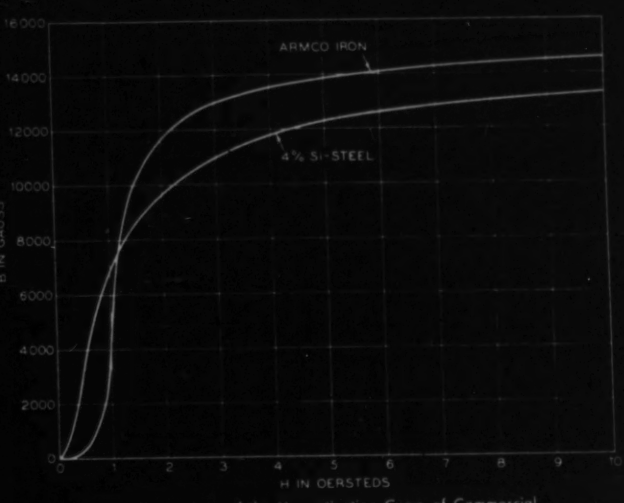


Fig. 3. A Comparison of the Magnetization Curve of Commercial 4% Silicon Steel[4] with that of Armco Iron[5] Showing the Superiority of the Former at Low Induction Densities.

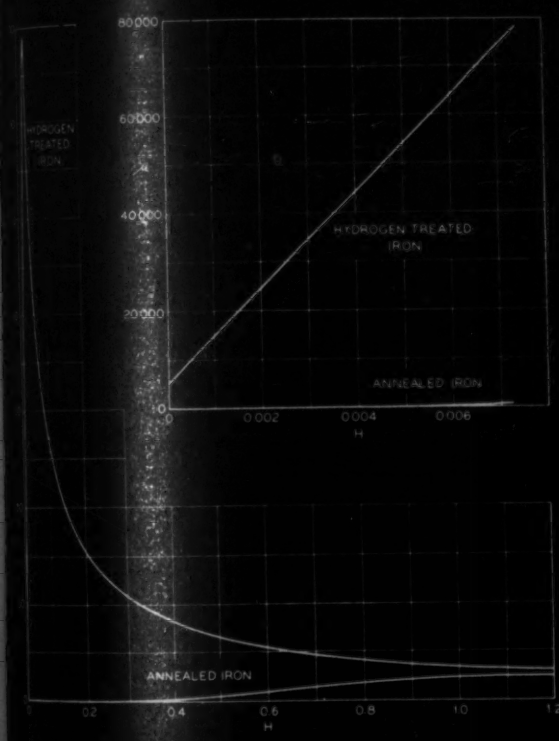


Fig. 4. The Permeability of a Laboratory Sample of Hydrogen Treated Iron Compared with that of Untreated Iron — Cioffi.[3]

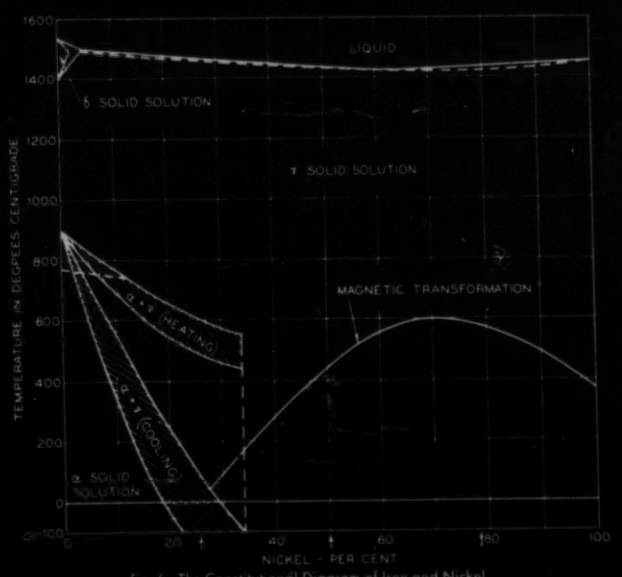


Fig. 5. The Constitutional Diagram of Iron and Nickel.

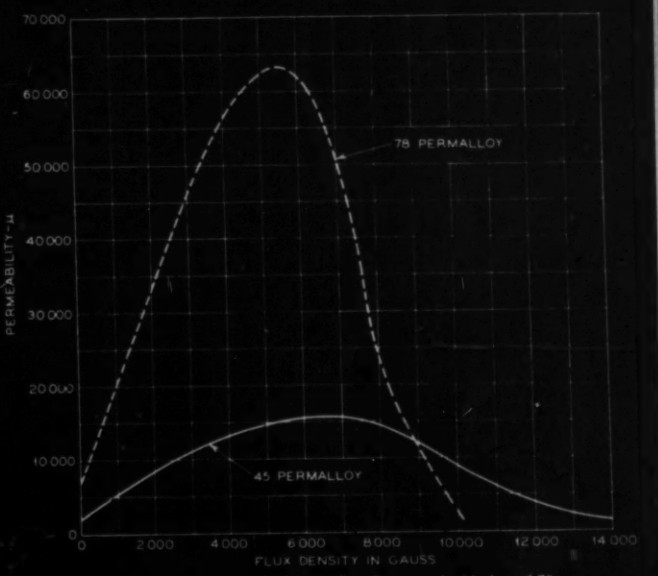


Fig. 6. The Permeability of 45 Permalloy Compared with that of 78 Permalloy — Pettit.[6]

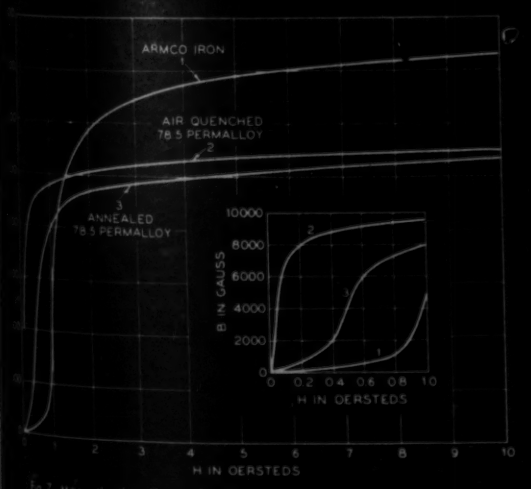


Fig. 7. Magnetization Curves for 78.5 Permalloy after Two Heat Treatments — Elmen.[7]

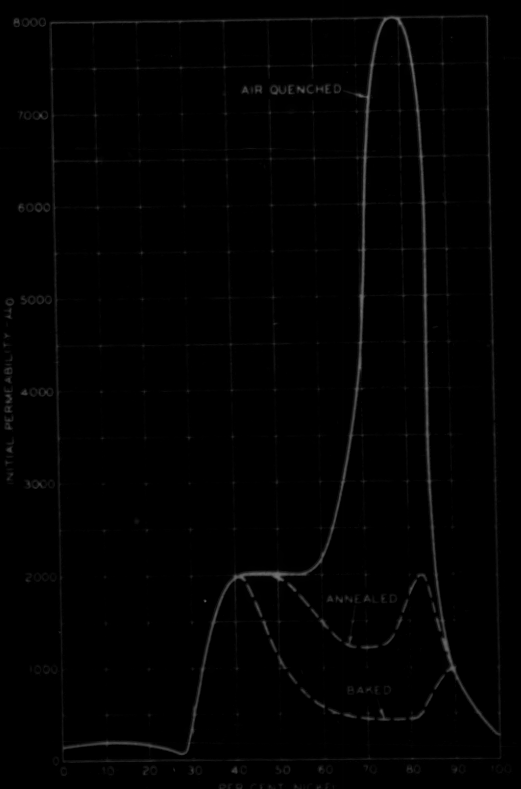


Fig. 8. Effect of Heat Treatment on Initial Permeabilities of Iron-Nickel Alloys — Elmen.

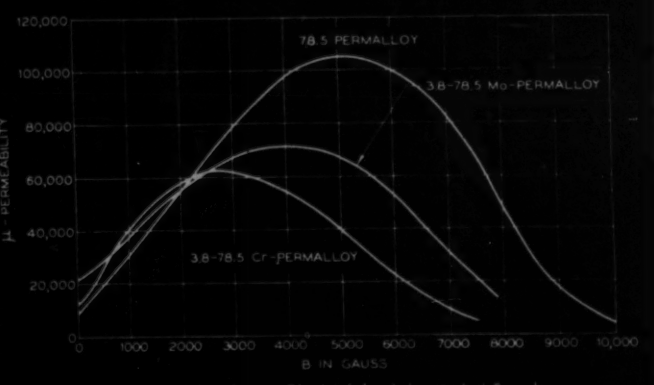


Fig. 9. Permeability Curves Obtained for Laboratories' Samples Comparing the Properties of Cr-Permalloy and Mo-Permalloy with those of Standard Permalloy — Elmen.[7]

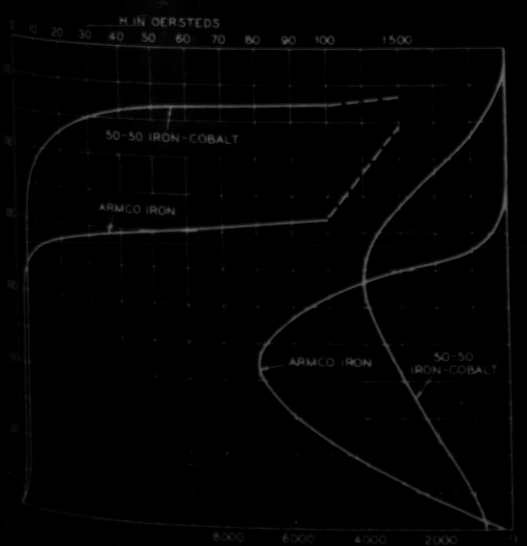


Fig. 10. Magnetization Curve and Permeability Curve for 50-50 Iron-Cobalt Alloy — Elmen.[7]

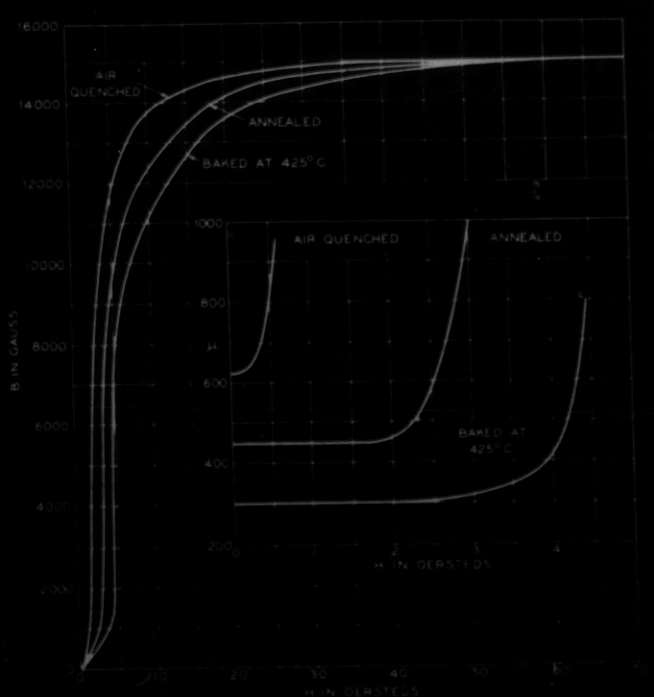


Fig. 11. Magnetization Curves for a Perminvar Containing 45% Ni, 25% Co and 30% Fe after Several Heat Treatments — Elmen.[7]

gen is either liberated as the metal cools, or, if it remains in the metal, is without harmful effects on the magnetic characteristics. A value of maximum permeability of 280,000 has been reported[11] for iron prepared in this manner. In Fig. 4 is reproduced a curve from the unpublished work of Cioffi showing the enormous improvement in magnetic softness achieved by the hydrogen treatment.

The mechanism of the purification is outlined by the reactions in Fig. 2. The carbon is eliminated as a hydro-carbon gas, probably methane; the oxygen as water vapor; the nitrogen as ammonia or as nitrogen gas due to thermal dissociation of nitrides; the sulphur as hydrogen sulphide; and the phosphorus probably as phosphine. The most probable explanation to account for the purification is that, at the high temperatures, the impurities continually diffuse to the surface of the sample where the reaction with hydrogen occurs. Another possibility is that the reactions occur within the body of the sample, in which case, the hydrogen must diffuse in and the reaction products out. The first possibility appears the more promising in that the diffusion of reaction products through the iron samples would be difficult, since, in general, the products are rather large molecules.

Another type of high purity iron which is being used for magnetic purposes is carbonyl iron[12] manufactured by the I. G. Farben Industries in Germany. It is prepared by first forming iron carbonyl under suitable conditions of temperature and pressure, and subsequently decomposing the carbonyl. For the best quality, the material is further purified by a low temperature hydrogen treatment. This iron is in the form of spherical particles, a few microns in diameter.

One use for this material is in cores of high frequency inductance coils. The cores of such coils are prepared by pressing the insulated magnetic particles into the desired core shape.

The material is also used in preparing iron sheet[13] and as an alloying constituent for the manufacture of iron-nickel alloy sheet.[14] The process of alloying consists of pressing the powders and sintering at a high temperature, followed by working and annealing in hydrogen or vacuum. Typical permeability values for iron sheet prepared in this manner are:

$$\mu_o = 2000\text{-}3000; \quad \mu_{max.} = 15000.$$

The values are decidedly lower than those for a laboratory sample of hydrogen-treated iron shown in Fig. 4.

Iron-Nickel Alloys

No alloy system has been more fruitful in yielding interesting and useful magnetic alloys than that of iron and nickel. In this system, the 3 regions marked with arrows on the constitutional diagram in Fig. 5 are of principal importance.

In the proximity of 25% nickel, which is the region of retarded phase change, alloys can be obtained at room temperature in the non-ferromagnetic state. How this is accomplished is evident from a consideration of the constitutional diagram. The γ solid solution above the magnetic transformation is non-ferromagnetic while the α solid solution is ferromagnetic. When alloys in the region of 25% nickel are cooled, the transformation to the ferromagnetic state is not completed until temperatures below room temperature are reached. If the alloy is cooled until the ferromagnetic structure is obtained, the transformation to the non-ferromagnetic state does not occur on heating until the temperature has reached approximately 600° C.

Elmen[17] has investigated alloys containing more than 30% nickel, which are characterized by great magnetic softness and have been called, "permalloys,"[17] the name suggesting high permeability. These alloys in the region of 40-55% nickel find industrial application as soft magnetic materials. They are used in telephone and radio transformers and telephone relays. An alloy typical of this region is the one containing 45% nickel. A curve[15] showing the permeability of this alloy is plotted in Fig. 6. From the data given on this curve, the material exhibits an initial permeability of 2000 and a maximum permeability of 16000.

Another alloy in this region is the one containing 50% nickel which has been investigated by Yensen. He has applied the name "Hypernik"[16] to it. Yensen, by giving this material a special heat treatment, obtained an initial permeability of 4000 and maximum permeability of 70000.

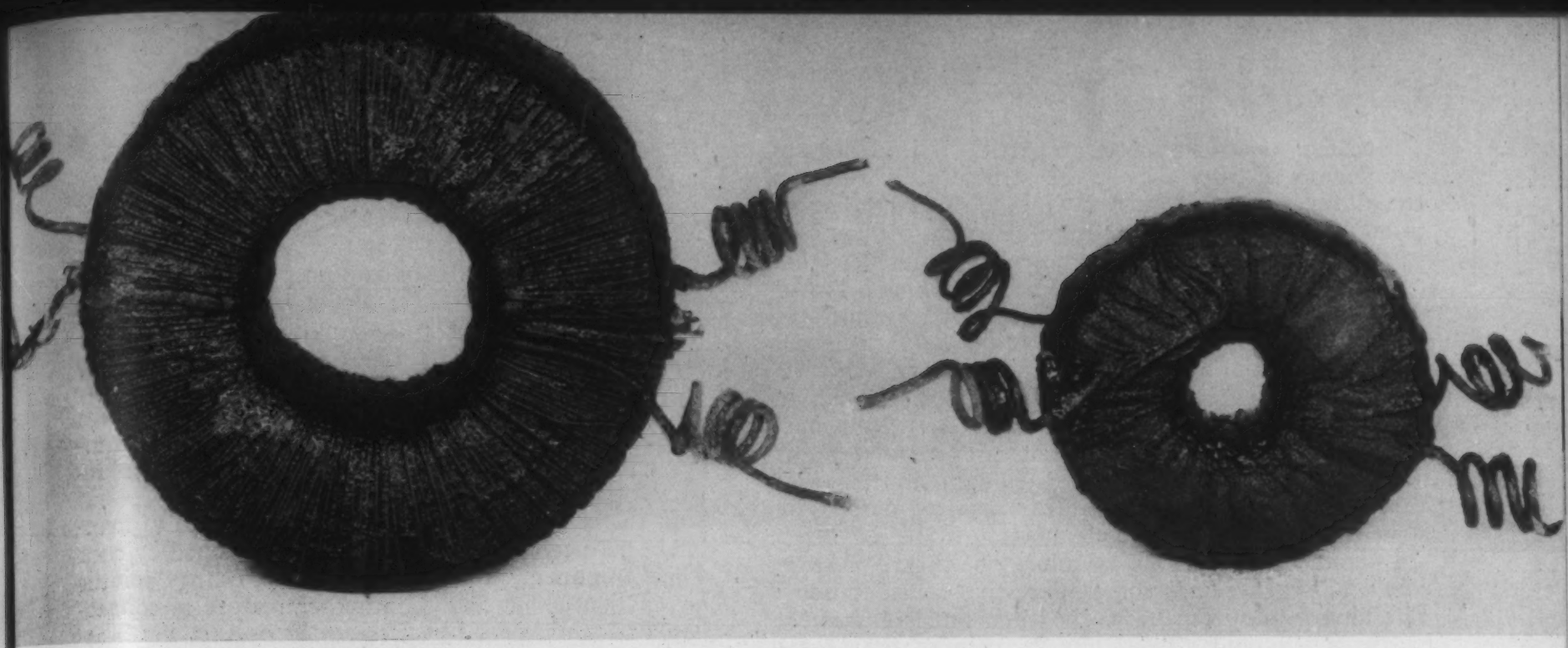
Arnold and Elmen[17] have investigated in great detail the alloys in the region of 70 to 80% nickel. These alloys are used where extremely high initial permeability is required. One especially interesting use is in the loading of submarine telegraph cable. An alloy typical of this region is the one containing 78.5% nickel. Magnetization curves for this alloy after 2 different heat-treatments are compared with the curve for annealed Armco iron in Fig. 7. In the air-quenched condition, in which the alloy is magnetically the softer, typical values for the initial and maximum permeability are 7000 and 65000, respectively.

In comparing the properties of 45% nickel and 78% nickel alloys with reference to Fig. 6, the initial permeability is higher for the higher nickel alloy. Therefore, for very low magnetizing forces, the higher nickel alloy is characterized by higher flux densities. For higher magnetizing forces, the 45% alloy has more attractive properties in that the flux density is higher. In addition, the electrical resistivity of the alloy is approximately 3 times that of the 78% alloy. The electrical resistivity is important in alternating current applications since the eddy current loss in sheet of the same physical dimensions varies inversely with the electrical resistivity of the material.

To the metallurgist, the effects of heat treatment in establishing the magnetic properties of iron-nickel alloys possess a great fascination. The effects in question are illustrated by curves shown in Fig. 8. In the region of 78% nickel, the maximum magnetic softness is exhibited after air-quenching, while increases in magnetic hardness are obtained after annealing or baking for extended times at low temperatures. The compositions near 50% nickel are not as much affected by heat treatment.

Elmen[17] attributed the heat treating effect to the separation of the homogeneous phase, stable at high temperatures, into 2 phases on slow cooling. The 2 phase structure under these conditions would be less magnetic. More recently in Germany, investigators[18] have advanced the analysis by postulating that in the region of 76% nickel, where the ratio of iron to nickel atoms is 1:3, the alloy can exist in 2 states; one, a solid solution state in which the atoms of iron and nickel are in a disordered distribution; and two, a state in which the iron and nickel atoms are regularly distributed.

In the disordered distribution the lattice points are fixed but the atom positions are not; that is, any lattice point may be occupied by either an iron or nickel atom. In the regular or ordered distribution, the lattice points are fixed and also the atom positions. The second arrangement may be clearer to some if it is considered



Loading coils: the left one wound on an iron dust core and the right one of similar magnetic characteristics wound on a permalloy dust core.

a "compound," although strictly speaking, the arrangement does not correspond to a compound in the chemical sense. The regular arrangement is now ordinarily called a "superlattice" or a "superstructure," and as such, will be designated in this paper. If it is clearer to the reader, he may substitute for the term "superlattice" or "superstructure," the term "compound" without great sacrifice in the sense of the discussion.

With this picture in mind, the effect of heat treatment is immediately evident. Rapid cooling prevents the formation of the "superlattice" arrangement, which occurs somewhere in the region of 500° C., and a disordered distribution of atoms is retained. This is the distribution possessing the higher magnetic permeabilities. Slow cooling or baking promotes the transformation to a superlattice of lower magnetic quality.

Heat treatment effects are much less in the alloys in the region of 50% nickel, and in fact would not be expected, since a face-centered cubic binary alloy with the atomic ratio of 1:1 would not be expected to have a special structure (superstructure).

The hypothesis of superlattice formation in the 75% nickel region is supported further by the effect of heat treatment on other physical characteristics, for example: the electrical resistivity and the tensile strength. That such special structures are formed in the solid states is well established from detailed studies of the copper-gold system.[19] Unfortunately, in the nickel-iron system where the nickel and iron atoms are so near in atomic number, the detection of superstructure by X-ray methods appears, at the present time, a difficult task.

The effect of heat treatment and the general magnetic softness of iron-nickel alloys in the region of 75% nickel may be explained by another hypothesis which returns for its basis to the considerations set forth in the section on high purity iron. The improvement in magnetic softness may be attributed, first, to the effect of nickel in decreasing the residual quantities of interstitial elements originally present in iron. Whether or not such an effect is present awaits a careful investigation of the interstitial element content of iron-nickel alloys. Secondly, assuming the interstitial elements the responsible factors, the effect[20] of heat treatment on magnetic quality can be explained in that the quench (rapid cooling) retains the residual elements in solution, while slow cooling permits precipitation in a form more deleterious to magnetic quality.

The 2 hypotheses possess interesting possibilities, but it appears that further investigation will be required before the structural relationships are definitely established.

The permalloys in the region of 75% nickel have been further modified by the addition of third elements[17] which are non-ferromagnetic. Molybdenum and chromium are elements of this nature which confer on the alloys certain characteristics of sufficient interest to warrant discussion. The effects of molybdenum and chromium on the magnetic quality are shown in Fig. 9, which indicates that higher initial permeabilities may be expected with the ternary alloys. The addition of a third element increases the electrical resistivity of the alloy. This is of importance in alternating current applications where eddy current losses are a consideration. In commercial manufacture the third element is particularly valuable, since it decreases the sensitivity of the magnetic properties of the alloy to the rate of cooling after annealing and, in fact, permits the attaining of high permeabilities with slow cooling. The significance of this from a structural viewpoint is that the third element keeps the iron and nickel atoms in a disordered distribution.

Iron-nickel alloys have a limited field of application in the form of thin tape in the hard rolled condition. A representative material is one containing from 30 to 70% nickel and, in addition, a few percent of aluminum or copper, which in the hard rolled condition has been called "isoperm."[21] The material is reported to have a low permeability of 50 to 75, which is fairly constant over a range of magnetizing forces of 0-10 oersteds. Laminated cores of this material have properties similar, but somewhat inferior to, those of magnetic dust cores[27] which are described in a later section of the paper.

Iron-Cobalt Alloys

Iron-cobalt alloys in the region of 50% cobalt are of importance for magnetic purposes because of the high values of flux densities obtained with medium magnetizing forces. The desirable magnetic properties of the alloy containing 50% cobalt were first reported by one[22] of the authors. A very complete investigation of alloys over the whole range of cobalt contents has been described by Elmen[17] from whose paper the curves shown in Fig. 10 are taken. With magnetizing forces from 5 to over 1500 oersteds the intrinsic induction is greater than that obtained with iron.

Because of anomalies in properties of the alloys in the region of 50% cobalt, the structural features of the alloys become of interest. In addition to the maximum in intrinsic induction, the electrical conductivity in this region at room temperature is greater than that of either of the components. The anomalous behavior was attributed several years ago by one of the authors,[22] not to compound formation, but to a "peculiar solid solution." Kussman, Scharnow and Schulze[22] in a recent paper attribute the effects to the formation of superstructure in the body centered lattice which exists at this point. This, in a sense, is an extension of the earlier explanation. Here again, it appears that further work is warranted and is required before the structure is completely understood.

In connection with the metallurgy of the 50-50 iron-cobalt alloy, there are some interesting considerations. The binary alloy can be worked hot, but is extremely brittle when cold. This imposes definite limitations where thin sheet produced by cold rolling is required. The limitation can be overcome by adding a few percent of vanadium[23] to the composition. This alloy can be worked hot, and after a quench from a high temperature, also can be cold-rolled to thin sheet. The magnetic characteristics are not greatly affected by the vanadium, provided the addition is small.

The structural changes resulting from the additions of vanadium are not clearly understood. It is known that vanadium retards the transformation which occurs in these alloys at approximately 900° C. and therein lies a possible explanation for its action. The high temperature modification is malleable as shown by satisfactory hot working properties. By quenching, sufficient of this modification may be preserved at room temperature, when vanadium is present, to permit cold rolling.

Iron-Cobalt-Nickel Alloys

In the ternary system, iron-cobalt-nickel, is a region in which the alloys exhibit an unusual and useful property, namely, constant permeability in low fields. Because of this characteristic, alloys in this region have been named perminvars.[24] A typical alloy with marked perminvar characteristics contains 45% nickel, 25% cobalt and 30% iron. The effects of heat treatment are illustrated in Fig. 11. The effect on the magnetization curve of air quenching, annealing, and baking at a low temperature is shown for this typical alloy. The extension of constant permeability to higher magnetizing forces by a low temperature bake is clearly demonstrated.

The constancy of permeability in perminvar has been explained in one hypothesis as due to the presence of two constituents in the alloy, one a soft magnetic material, the other a hard magnetic material. The experimental evidence for this hypothesis is derived largely from the constricted hysteresis loops which are obtained for these alloys after a baking treatment. A similar type of constricted loop can be obtained in a magnetic sample which is composed of thin parallel sheets of a soft and of a hard magnetic material magnetized longitudinally.

It may be that the 2 constituents result from a process similar to that described for the iron-nickel alloys in the region of 75% nickel. In line with this, the baking treatment may form a superstructure[24] which is magnetically hard, but to a greater degree, than the one in the binary iron-nickel alloys. It is probable that the similar effects of heat treatments in the binary and ternary alloys are due to similar structural transformations.

Heat Treatment of Magnetic Material in Magnetic Field[25]

Recently it has been reported that radical changes have been produced in the magnetic properties of some ferromagnetic alloys by heat treatment in a magnetic field. For example, the maximum permeability of the permalloy containing 65% nickel has been increased from 10,000 to 250,000 by heating to 700° C. and cooling slowly in a field of 15 oersteds. The maximum permeability has been further increased to 600,000 by so treating a specimen which had previously been treated in hydrogen at 1400° C. This value of maximum permeability is the highest which has been reported for any ferromagnetic material.

In the iron-cobalt-nickel alloys, high values of maximum permeability are also generally obtained by such a heat treatment, provided the magnetic change point is higher than about 500° C. Another feature in connection with this special heat treatment is that the heat-treated specimens have hysteresis loops which tend to have sharp corners and vertical sides.

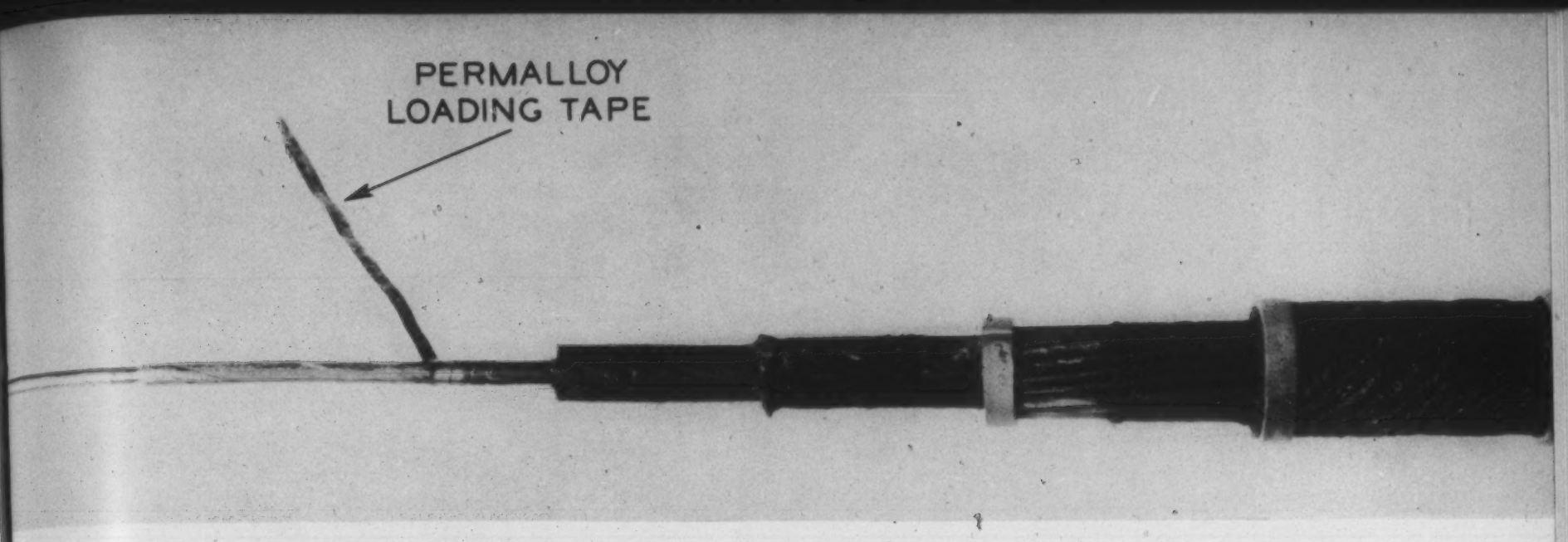
An interesting explanation for the effect of heat treatment in a magnetic field is given by Bozorth.[25] According to modern magnetic theory, when a specimen is cooled through the Curie point in the absence of an applied field, small regions or domains are magnetized to saturation in definite directions. The specimen in its entirety exhibits no external magnetic effects since the vector sum of the individual effects would be nearly zero and not detectable. The magnetization of the domains produces internal strains in the material due to lengthening in one direction and contraction at right angles (magneto-striction). By the application of an external magnetic field in the temperature region near to, but below, the Curie point, 1. the magnetic domains are oriented nearly in the direction of the applied field, and 2. the internal strains which were introduced by the local magnetization at the Curie point are removed by plastic flow of the surrounding domains. For this to occur, the temperature of Curie point must be higher than that at which plastic flow begins. Subsequent application of an external magnetic field at room temperature in the direction of, or opposite to, the direction of the magnetization at the higher temperature introduces no strains in the material tending to decrease the ease of magnetization. For that reason relatively higher permeabilities are obtained than with material heat treated in the absence of a field, in which case opposing strains are present.

The theory also offers another explanation for the effects of heat treatment on the permalloys in the region of 75% nickel. This explanation will not be discussed further here except to say that it is concerned with the same magneto-strictive strains as have been mentioned above.

The fundamental idea of the theory proposed to account for the effects of heat treatment in a magnetic field, and the general effects of heat treatment on certain ferromagnetic materials, is that the magneto-striction associated with the local magnetization in the domains is sufficient to cause plastic flow. Experimental data indicate that the magneto-strictive stress is sufficient to cause such plastic flow at about the temperature which is known to be critical for the heat treatment of the permalloys.

Heusler Alloys

One of the most interesting groups of magnetic materials comprises the Heusler alloys[26] which are ferromagnetic although composed of non-ferromagnetic



Modern submarine telegraph cables are loaded with a wrapping of permalloy tape around the conductor.

elements. A representative alloy of this type is one containing copper, manganese, and aluminum. The magnetic properties are associated with the composition Cu_2MnAl, since the magnetic intensity of the alloys varies in proportion to the amount of this phase. These properties also depend upon structure.[26] The ferromagnetic condition is obtained by quenching the alloy from approximately 800° C. This treatment produces a body centered cubic structure with a face centered superlattice. Manganese is essential to the composition; copper may be replaced by silver;[26] aluminum by other trivalent or tetravalent elements—for example, tin.

Although possessing no properties of commercial utility, the alloys are extremely important in relation to magnetic theory. For those who may be particularly interested, a rather complete list[26] of recent papers on the subject are given in the references.

Summary of Magnetic Characteristics of Sheet Materials

There are now available for magnetic purposes a large number of materials which are suitable for use over different ranges of magnetizing force and at different flux densities. In summarizing properties, the materials are grouped according to their adaptability at different magnetizing forces.

For low forces, where very high permeabilities are required, as in some signal apparatus, 78-permalloy is a suitable material. Molybdenum or chromium permalloy has properties similar to those of 78-permalloy but has higher initial permeability, is more readily heat-treated and is to be preferred for alternating current applications because of the higher resistivity. Hydrogen-treated iron at low magnetizing forces also has properties similar to those of the 78-permalloy.

For small magnetizing forces where a constant permeability and very low hysteresis loss is required, the heat-treated perminvars are available. The flux densities in cores of this type, if constant permeability and low hysteresis loss are retained, must be kept below 1000 gauss. For apparatus using higher magnetizing forces, iron-nickel alloys in the range of 40 to 55% nickel, and the silicon steels are most suitable. These 2 materials are widely used in electric transformers.

In the region of fields of 10 to 50 oersteds and higher, the 50-50 iron-cobalt and vanadium-modified alloy are attractive because of the high intrinsic induction of approximately 22000 gauss. This superiority exists even in fields of over 1000 oersteds, but in the higher ranges, the saturation value is approached by that of the less expensive material, magnetic iron. In connection with high flux density applications, the permalloys, the perminvars, and modified alloys of this character are of little interest since they are saturated at comparatively low flux densities.

The data given here are not sufficient to select a material for a specific application since many other detailed properties must be considered in connection with each individual problem. The materials which have been described, however, cover, in a general manner, the entire range of magnetic fields.

Magnetic Alloys in Dust Form

For certain purposes where a substantially constant low permeability is desired, and in particular, for high frequency applications where eddy current losses are of consequence, it is desirable to produce the magnetic material in a fine powder, which is subsequently insulated and pressed into the desired core shape. One alloy prepared in this form is the permalloy[27] containing approximately 80% nickel. This is a material suited for use at audio frequencies, for example in the cores of loading coils.

The alloy may be prepared in powdered form by a number of methods. In one method, which is essentially metallurgical in nature, advantage is taken of the effect of small amounts of added elements.[27] It has been found that the addition of a few thousandths % sulphur to the iron-nickel alloy containing approximately 80% nickel produces a structure which can be hot-rolled to a small section, but which when cold, is exceedingly brittle and can be pulverized to a fine dust. The presence of other elements in small amounts also affects the properties of the alloy. One element, manganese, has an effect opposite to that of sulphur, and if present in sufficiently large amounts, nullifies the action of sulphur by producing a tough and malleable casting.

The structural behavior of sulphur and manganese in permalloy is interesting in explaining the embrittling action. Sulphur exists in the structure as microscopic films of complex sulphides at the crystallite boundaries as illustrated in Fig. 12. These films are brittle, and when they extend over the greater portion of the crystallite surface, produce an interface of weakness permitting easy pulverization. The satisfactory hot-working properties can be explained in that at the high temperature, either the sulphide film is malleable, or dissolves in the iron-nickel solid solution. If manganese is added to an alloy containing sulphur, the sulphide constituent is blackened, loses its continuous characteristics, and becomes agglomerated as is well known in the case of iron and of nickel. In this form it has a minimum embrittling effect since contact between metallic crystallites exists over the greater proportion of the interface. The structure is illustrated in Fig. 13. If sufficient manganese is present, alloys containing fairly high percentages of sulphur can not only be hot worked, but are malleable when cold.

Fig. 12. Structure of an Iron-Nickel Alloy, as cast, containing 80% Ni and 0.030% S. The Sulphide constituent exists as a brittle film surrounding the crystallites. Mag. 2000 ×

Fig. 13. Structure of an Iron-Nickel Alloy containing 80% Ni to which had been added 0.12% S and 1.05% Mn. The Sulphide constituent exists along the crystallite boundaries as grayish rounded inclusions. Mag. 2000 ×

The production of magnetic dusts is unique as a metallurgical process since the metallurgist is concerned with adding elements yielding a product which can be pulverized to a fine dust. Generally, the metallurgist exercises his greatest ingenuity to produce ductility and malleability in the end product.

References

[1]K. L. Scott. Magnet Steels and Permanent Magnets. *Electrical Engineering*, Vol. 51, 1932, page 320.

S. Evershed. Permanent Magnets in Theory and Practice. *Journal Institution of Electrical Engineers*, Vol. 63, 1925, page 725.

[2]Messkin-Kussmann. Die Ferromagnetischen Legierungen. Julius Springer, Berlin, 1932, page 308.

[3]H. Scott. Solubility of Carbon in Alpha Iron. *Chemical & Metallurgical Engineering*, Vol. 27, 1922, page 1156.

J. H. Whiteley. Solution of Cementite, in α-Iron and Its Precipitation. *Journal, Iron & Steel Institute*, Vol. 116, 1927, page 293.

A. A. Bates. Aging in Low Carbon Steels. *Transactions, American Society for Steel Treating*, Vol. 19, 1932, page 449.

[4]F. S. Tritton & D. Hanson. Ferrous Alloys Research-Pt. II—Iron and Oxygen. *Journal, Iron & Steel Institute*, Vol. 110, 1924, page 90.

L. Jordan & J. R. Eckman. Gases in Metals II—Determination of Oxygen and Hydrogen in Metals by Fusion in Vacuum. *Scientific Paper, Bureau of Standards* 514, Vol. 20, 1925, page 445.

[5]S. Epstein. Observations on the Iron-Nitrogen System. *Transactions American Society for Steel Treating*, Vol. 16, 1929, page 19 (Nitriding Symposium).

[6]C. Benedicks & H. Löfquist. Nonmetallic Inclusions in Iron and Steel. Chapman & Hall, London, 1931.

[7]W. F. Barrett, W. Brown & R. A. Hadfield. On the Electrical Conductivity and Magnetic Permeability of Various Alloys of Iron, Pts I and II. *Scientific Proceedings, Royal Dublin Society*, Vol. 7, Series 2, 1900, page 67.

T. D. Yensen. Magnetic and other Properties of Iron Silicon Alloys Melted in Vacuo. *Illinois University Engineering Experiment Station Bulletin* No. 83, 1915.

[8]Messkin-Kussmann. Die Ferromagnetischen Legierungen. Julius Springer, Berlin, 1932, page 312.

[9]T. D. Yensen. Pure Iron and Allotropic Transformations. *Transactions, American Institute of Mining & Metallurgical Engineers, Iron and Steel Division*, 1929, page 320.

[10]W. Rohn. Die Entwicklung der Heraeus—Vacuum Schmelze A-G, von 1923-1933. Heraeus Vacuum-Schmelze 1923-1933, Hanau, 1933, page 1.

[11]P. P. Cioffi. New High Permeabilities in Hydrogen-Treated Iron. *Physical Review*, Vol. 45, Series 2, 1932, page 742.

[12]Iron Carbonyl Patents. British No. 244895; German No. 518387; U. S. Nos. 1783744, 1759268, 1725619.

A. C. Fieldner & G. W. Jones. Iron Carbonyls: Their Physical and Chemical Properties. *American Gas Association Monthly*, Vol. 6 1924, page 439.

[13]O. Buddenberg, F. Duftschmid & L. Schlecht. Reines Carbonyleisen als hochpermeabler magnetischer Werkstoff. Heraeus Vacuum-Schmelze 1923-1933, Hanau, 1933, page 74.

[14]G. Keinath. Hochmagnetische Legierungen aus Nickeleisen. *Archiv für technisches Messen*, Vol. 2, 1932, page T 173.

[15]I. C. Pettit. Magnetic Materials. *Bell Laboratories Record*, Vol. 3, Oct. 1934.

[16]T. D. Yensen. Magnetic Properties of the Fifty Per Cent Iron-Nickel Alloy. *Journal, Franklin Institute*, Vol. 199, 1925, page 333.

[17]H. D. Arnold & G. W. Elmen. Permalloy, an Alloy of Remarkable Magnetic Properties. *Journal, Franklin Institute*, Vol. 195, 1923, page 621.

G. W. Elmen. Magnetic Alloys of Iron, Nickel, and Cobalt. *Journal, Franklin Institute*, Vol. 297, 1929, page 583.

[18]O. Dahl. Zur Frage Unterkühlbarer Zustandsänderungen in Eisen-Nickellegierungen. *Zeitschrift für Metallkunde*. Vol. 24, 1932, page 107.

[19]J. L. Haughton & R. J. Payne. Transformations in the Gold-Copper Alloys. *Journal, Institute of Metals*, Vol. 46, No. 2, 1931, page 457.

[20]A. Kussmann, B. Scharnow & W. Steinhaus. Über das Permalloy-Problem. Heraeus Vacuum-Schmelze 1923-1933, Hanau, 1933, page 310.

O. Dahl & J. Pfaffenberger. Beitrag zur Kenntnis der Eisen-Nickel Legierungen. *Zeitschrift für Metallkunde*, Vol. 25, 1933, page 241.

[21]O. Dahl, J. Pfaffenberger & H. Sprung. Neuartige magnetische Werkstoffe für Pupinspulen (Materialien höchster magnetischer Stabilität; Ispoerme) *Elektrische Nachrichten Technik*, Vol. 10, 1933, page 317.

[22]W. C. Ellis. A Study of the Physical Properties of Electrolytic Cobalt and its Alloys with Iron. *Rensselaer Polytechnic Institute, Engineering and Science Series*, No. 16, 1927.

A. Kussmann, B. Scharnow & A. Schulze. Physikalische Eigenschaften und Struktur des Zweistoffsystems Eisen-Kobalt. *Zeitschrift für technische Physik*, Vol. 13, 1932, page 449.

[23]J. H. White & C. V. Wahl. U. S. Patent No. 1,862,559.

[24]G. W. Elmen. Magnetic Properties of Perminvar. *Journal, Franklin Institute*, Vol. 206, 1928, page 317.

O. Auwers & H. Kühlewein. Beitrage zum Stereomagnetismus II—Uber das Perminvar-problem. *Annalen der Physik*, Vol. 17, Series 5, 1933, page 121.

[25]G. A. Kelsall. Permeability Changes in Ferromagnetic Materials Heat Treated in Magnetic Fields. *Physics*, Vol. 5, 1934, page 169.

R. M. Bozorth, J. F. Dillinger & G. A. Kelsall. Magnetic Materials of High Permeability Attained by Heat Treatment in a Magnetic Field. *Physical Review*, Vol. 45, Series 2, 1934, page 742.

L. W. McKeehan & P. P. Cioffi. Magnetostriction in Permalloy. *Physical Review*, Vol. 28, Series 2, 1926, page 146.

L. W. McKeehan. Ferromagnetism in Metallic Crystals. *Metals Technology*, Aug. 1934, Technical Publication No. 554, 42 pages.

R. M. Bozorth. Theory of the Heat Treatment of Magnetic Materials. *Physical Review*, Vol. 46, 1934, page 232.

[26]F. Heusler. Über den Zusammenhang der magnetischen und mechanischen Eigenschaften der gewalzten Heusler-Bronz (Mangan-Aluminum-Kupfer) *Zeitschrift für Physik*, Vol. 10, 1922, page 403.

E. Persson. Über den Bau der Heuslerschen Legierungen. *Zeitschrift für Physik*, Vol. 57, 1929, page 115.

H. H. Potter. Some Magnetic Alloys and Their Properties. *Philosophical Magazine*, Vol. 12, Series 7, 1931, page 255.

A. K. Bradley & J. W. Rogers. The Crystal Structure of the Heusler Alloys. *Proceedings, Royal Society*, Vol. 144, Series A, 1934, page 340.

O. Heusler. Kristallstruktur und Ferromagnetismus der Mangan-Aluminium Kupferlegierungen. *Annalen der Physik*, Vol. 19, Series 5, 1934, page 155.

[27]W. J. Shackelton & I. G. Barber. Compressed Powdered Permalloy. *Transactions, American Institute of Electrical Engineers*, Vol. 47, 1928, page 429.

J. H. White. U. S. Patent No. 1,739,052.

C. P. Beath & H M. E. Heincke. U. S. Patent No. 1,669,649.

J. W. Andrews. U. S. Patent No. 1,703,287.

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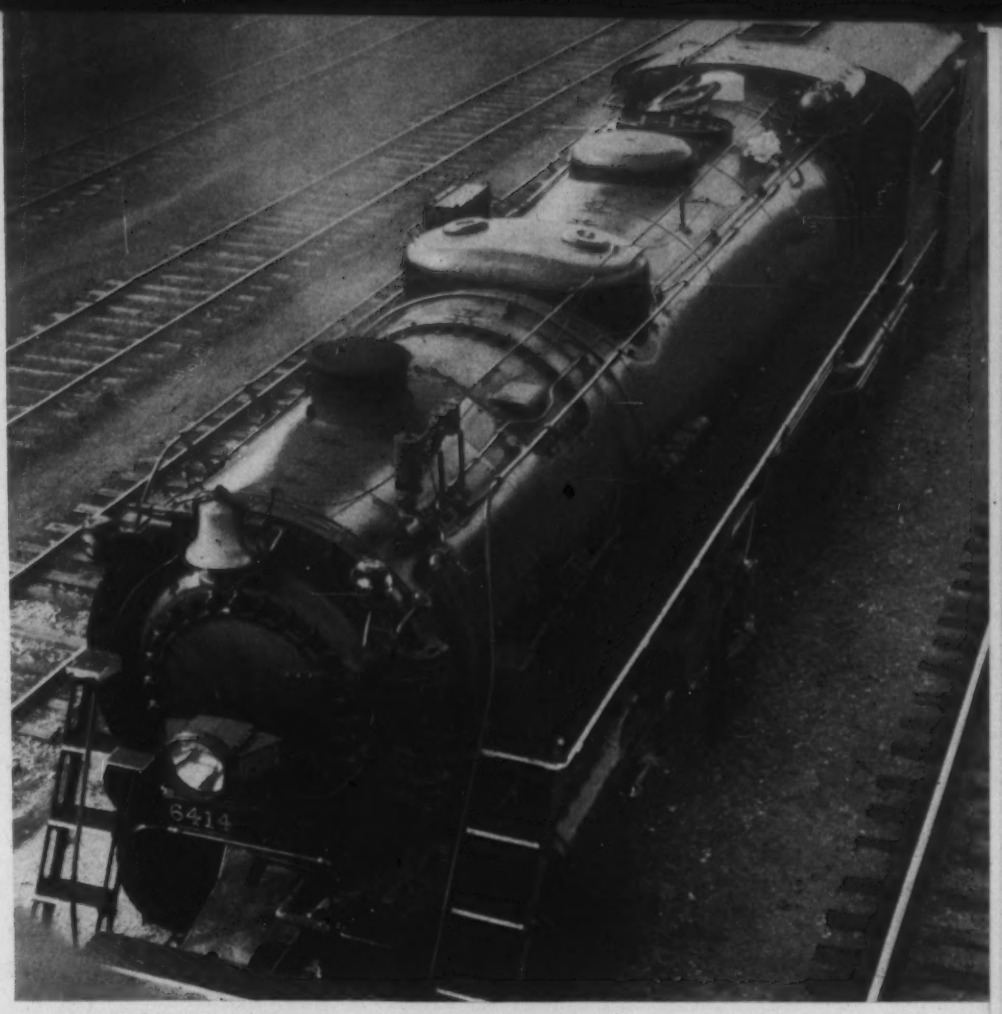


Hudson Type Locomotive

LOCOMOTIVE TIRES

A Discussion of the Causes of Typical Tire Failures

(Continued from November)

By Leland E. Grant *

Method of Manufacture

LOCOMOTIVE tires are, in general, purchased to the A.R.A. specifications which cover three grades as follows:

Grade	A	B	C
Service	Passenger	Freight	Switch Engines
Composition			
Carbon %	0.50-.70	0.60-.80	0.70-.85
Manganese %	0.50-.75	0.50-.75	0.50-.75
Phosphorus %	0.05 max.	0.05 max.	0.05 max.
Sulphur %	0.05 max.	0.05 max.	0.05 max.
Silicon %	0.15-.35	0.15-.35	0.15-.35
Physicals			
Tensile strength, lbs./in.²	105,000 min.	115,000 min.	125,000 min.
Yield point, lbs./in.²	.....	.....	.....
Elongation %	12	10	8
Reduction in area %	16	14	12

Most of the steel is made by the open hearth process, and may be acid or basic, acid steel being the most common. There are two methods commonly used in making tires; a third method not used extensively will also be described. In one process, individual ingots, large enough for only one tire, are cast. This ingot is heated, flattened in a press, the center punched out, and the blank thus formed hammered partly to shape before it is transferred to the tire rolling mills for finishing. Work is finished above the critical range and the tires placed on a car to cool in the air. Punching out the center is expected to remove all of the impurities segregated in this portion. In the opinion of the author this method has advantages over one of the other methods but it is believed that another method will produce more uniform tires with a finer grained structure.

In the second method, large ingots of special shape are cast in bottom poured molds equipped with hot tops. The cold ingots are cut up in slicing lathes to the proper size for a tire. Heating, flattening, and punching are the same as in the first method. After punching, the disc is immediately transferred to the rolling mills where the tire is finished, no hammering being done in this process. Cooling is the same as before. Tires made by this process have a coarser dendritic structure than those made by the first process, a difference believed to be due partly to the absence of hammering. It is a curious thing that such a coarse dendritic structure with very long dendrites should persist after the steel has been reduced so extensively in cross section. Tires consistently exhibit the coarsest and most clear cut dendritic structure of any forgings examined in this laboratory. Just why a section of ingot rolled to hoop shape should have much coarser dendrites than similar steel rolled into bar shapes is not apparent.

The third method of making tires has not been used extensively. In this process the raw stock consists of a billet of suitable size for the tire to be made. The billet is first rounded up under a hammer and then set vertically on a press where it is flattened. This corresponds to the similar process in the other methods. The center is next punched out and the blank transferred to a rolling mill. The first mill rolls the tire roughly to shape. Following this operation the forging is placed in a furnace for reheating and equalizing the temperature throughout the section. This is very desirable practice as it avoids the necessity for heating the billet to an extremely high temperature in the first place as is necessary when the tire is rolled in one heat. After reheating, the blank is put on the final mills, two operations being required to finish the tire. A normalizing treatment is given all tires after cooling from the final rolling.

It has been suggested that this method of making a ring forging from a billet might result in a rather poor condition of the flow lines. Instead of showing smooth circumferential flow they might flow irregularly or even across the tire in a transverse direction. It should be borne in mind though that it is common practice in the industries to make ring forgings by the upset process, beginning with a small bar which has much more definitely oriented flow lines than has a billet. Yet these upset forgings have very good flow lines in a circumferential direction. Examination of some etched sections of tires made by this process has not shown any tendency for abnormal flow lines; in fact the flow lines are quite inconspicuous. Presum-

* Chief Chemist, Chicago, Milwaukee, St. Paul & Pacific Railroad Company.

ably the combination of flattening and rolling is sufficient to establish the flow around the tire as in any other process. Furthermore it is quite apparent that the metal receives much more work by this process than in any other. If a good sized ingot is used in making the billet there is considerable work done at this stage. The additional work involved in the hammering, upsetting, and final rolling is sufficient to break up the dendritic structure and refine the grain as shown by etched specimens. There should also be improvement in the directional properties but data on transverse specimens are not yet available.

The method of making tires from a billet has the additional advantage that it is possible to carefully inspect before rolling each billet to be used in the manufacture of tires for heavy service. If it were justified an etch test could be made as is done for other forging steels. And in any event a billet is better adapted to any kind of inspection than is a section of an ingot. It has had enough work done on it to show up any serious defects.

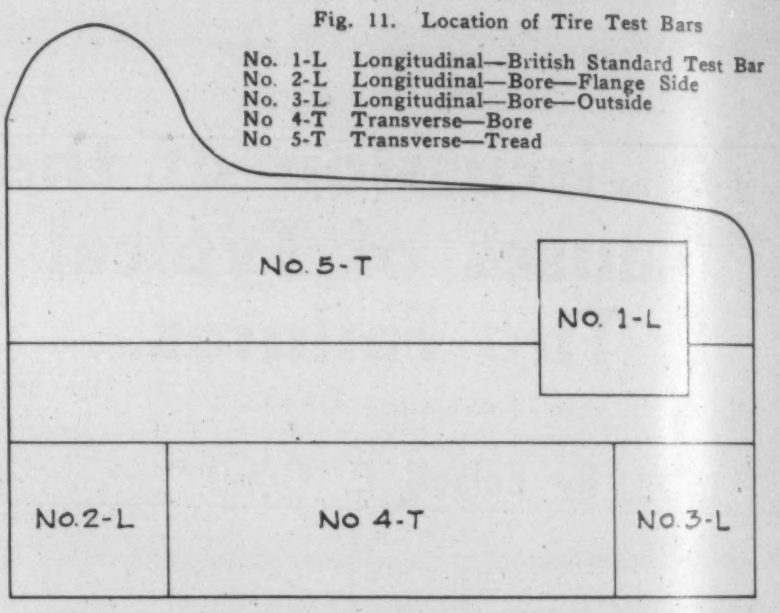
It was indicated above that the heat test bars, usually provided, do not yield physical results that are characteristic of the metal in the tires as rolled. The test bars are turned from a bar about 1¼ inches square. This square bar is made by forging the entire cross section of a small test ingot cast at the time the heat is poured. The ingot is approximately 4 inches square and weighs around 90 lbs. The reduction to 1¼ inches is roughly equivalent to that given the ingot in making a tire. Comparison of the properties of these test bars with those obtained from bars cut from tires reveals a wide variation. It must, of course, be borne in mind that there are advantages in the way of freedom from segregation and generally improved properties resulting from casting steel in small ingots that account for some of the differences noted. But it will later be shown that hammering down the tire itself will bring about a similar improvement in physical properties. The following may be taken as fairly representative of the difference between tire test bars and heat test bars:

	Heat Test Bar	Bar from a Tire from the Same Heat
Yield Point, lbs./in.²	61,100	62,000
Tensile Strength, lbs./in.²	114,300	111,100
Elongation %	20.0	15.0
Reduction in Area %	39.2	18.4

Much greater differences than this are frequently found, and, on the other hand, an occasional tire shows much less difference. It is evident that the heat test bar has but little significance in indicating what may be expected of tires from that heat.

The objection may be raised that if a tire has been in service the physicals no longer represent the original metal. If this were the case there would be but little gained by taking a test bar from any failed tire. In this laboratory test bars from very thin, nearly worn out tires, have been found to show the same general difference from the heat test bars as do bars from practically new tires that have failed or which were defective. If service conditions affected the properties of the metal very extensively this condition could hardly exist. Furthermore, the few examples available of results from unused tires show the same difference. In addition, some forging experiments, in which tires were forged to bars 1¼ inches square in both directions with respect to the original direction of rolling, gave physical results equal to those from the heat test bars. The poorer physicals of the tires can, therefore, be accepted as representative of the difference between tires as rolled and the heat test bars. It would, therefore, seem to be much more satisfactory to drop test a tire from each heat and cut test bars from the least deformed sections. Physicals from such bars would have value. Unfortunately this is an expensive method of testing especially when but few tires are being ordered. But in any event it would appear to be better to occasionally drop test a tire than to place much reliance in the test bars produced by the method discussed above.

Fig. 11. Location of Tire Test Bars



In order to learn as much as possible about the quality of the steel it has been the practice in the Milwaukee's laboratory to cut transverse test bars from many of the failed tires. There is much evidence that the highest quality steels show better agreement between the properties of test bars which are cut parallel and normal to the direction of rolling than do the inferior grades. Fig. 11 shows the general relationship of the specimens with respect to the cross section of a tire. Tables 2 and 3 show the results of tests. Special notice should be taken of the ductilities and of the difference between the tire test bars and heat test bars.

Table 2

Longitudinal Specimens	Location of Test Bar	Yield Point lbs./in.²	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Bore					
Under Flange...	2-L	51,800	108,000	13.5	15.7
Outside	3-L	56,200	108,800	14.5	21.0
Transverse Specimens					
Bore	4-T	50,300	107,300	8.0	8.5
Tread	5-T	62,300	106,000	4.5	4.6
Heat test bar.....		67,700	117,900	17.6	34.7

The Speeding Pioneer Limited

Table 3

Longitudinal Specimens	Location of Test Bar	Yield Point lbs./in.²	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Bore					
Under Flange...	2-L	60,800	121,700	15.5	19.6
Outside	3-L	63,800	117,200	15.0	19.7
Transverse Specimens					
Bore	4-T	56,800	109,700	5.0	5.2
Tread	5-T	61,000	111,600	5.0	4.3
Heat test bar.....		68,000	121,500	18.0	28.0

The lower ductility of the transverse bars is due to the elongation of inclusions in the direction of rolling and to the flow lines that are formed as a result of the elongation of segregated areas. The segregation is more likely to show up in tires than in other forgings because the metal has had only the single heating. This does not allow time enough for diffusion to take place. Longer soaking before rolling would help to eliminate this. The lack of repeated (or prolonged heating) may also account for the fact that tires show a much more distinct dendritic pattern when deep etched than the majority of other forgings. Fig. 12 is a good example. It is very rarely that an axle, for example, which is a much heavier forging, will show such distinct dendrites.

Non-metallics also are probably partly responsible for the low ductility of the transverse specimens. This, of course, like the matter of dendrites, is a moot point and each metallurgist has his own ideas about the harmful effect (or lack of it) of inclusions and dendrites in forging steels. There probably is nothing to be gained by discussing this problem further here but it is appropriate to suggest that when inclusions, such as are shown in Fig. 13, are found in failed tires in conjunction with a dendritic structure like that in Fig. 12, one is justified in raising a question as to whether or not this is the most suitable steel to use for locomotive tires.

When tires are made by forging in a single heat one can not expect a minimum grain size in the finished forging. A coarse grain is a hindrance in obtaining the best possible ductility. This factor alone would be sufficient to warrant giving tires a normalizing treatment after forging, disregarding for the moment the additional benefits of stress relief. Fig. 7 shows a more or less typical grain structure of tires while Fig. 14 shows effective breaking up of these grains by a normalizing heat treatment. From what has been said above it is clear that making tires by the billet process should help materially in producing finer grained steel because of the more logical heating cycle. In addition the repeated heating of the metal in this process promotes diffusion and should help to break up the dendrites. Examination of such tires shows this to be the case. This reduction in grain size and more complete elimination of segregation should improve the physical properties on the average and be conducive to a reduction in tire failures.

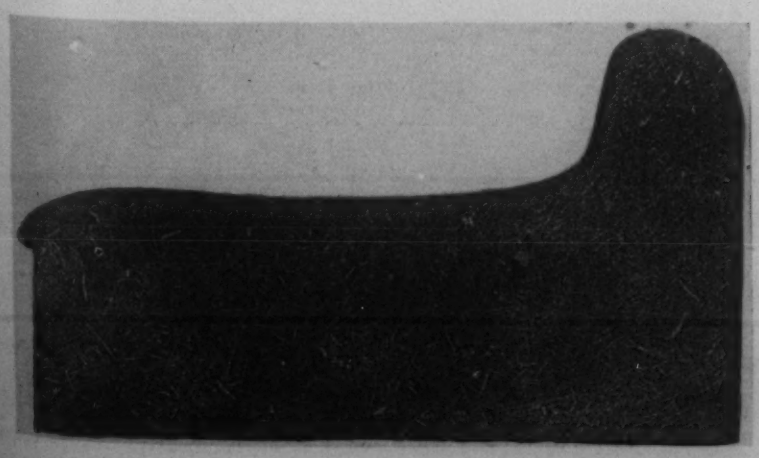


Fig. 12. Dendritic Structure in Tires. Approx. ½ size.

That additional heating and forging will materially improve the properties of tire steel in the "as rolled" condition is shown by the results obtained from forging part of a failed tire. A section of a failed tire was forged down both longitudinally and transversely to about 1¼ inches square. Portions of the bars so made were then normalized. The physical properties of the forged, and forged and normalized bars were compared with those obtained from the failed tire. For completeness the results from the heat test bar are also given.

Fig. 13. Inclusions in Tire Steel — Transverse section. Magnification 100 ×

Fig. 14. Structure of Tire Steel After Normalizing. Magnification 100 ×

Test Bar from the Failed Tire	Position of Test Bar	Yield Point lbs./in.²	Tensile Strength lbs./in.²	Elongation %	Reduction of Area %
Longitudinal	2-L	61,600	113,800	13.0	15.5
Transverse (Bore)	4-T	57,700	108,600	7.5	8.7
Forged from the Failed Tire					
Longitudinal		69,400	118,800	15.0	24.2
Transverse		58,000	117,300	13.5	14.7
Forged and Normalized					
Forged longitudinal		60,700	118,500	14.0	23.3
Forged transverse.		63,700	119,200	14.0	20.0
Heat test bar.....		72,300	123,900	17.3	29.8

Forging and normalizing produces essentially the same physical properties regardless of the direction of forging, though the bars still are not equal to the heat test bar. The bad effects of segregation, dendrites, coarse grain, and inclusions are largely overcome.

Tires Worn Out in Service

Tires that wore out in service have been examined at times in an effort to find out how they differ from tires that fail. Very little difference has been found. One of the principal differences has been that free ferrite was not as noticeable as it usually is in failures. Free ferrite appears to be an undesirable structural element in tires. The quantity is too small to

have any value in increasing the ductility, and, since it is relatively weak, a network of it, more or less surrounding the grains of stronger pearlite, cannot add anything to the strength. By far the majority of failures have been in the class A tires in which ferrite is more prominent, thus indicating that the ferrite is a weakening influence. It can hardly be said now that the service conditions for passenger engines are any more severe than for freight engines, so that severity of service is not the reason for the failures. If a grade B tire is required or desirable for freight engines and gives good service, there is every reason to believe that this would be found to be the case if this grade tire were applied to passenger engines. The larger number of failures in the grade A tires appears to bear this out.

Classification of Failures

Classification of nearly 50 failed tires into groups according to the manner in which they have failed is

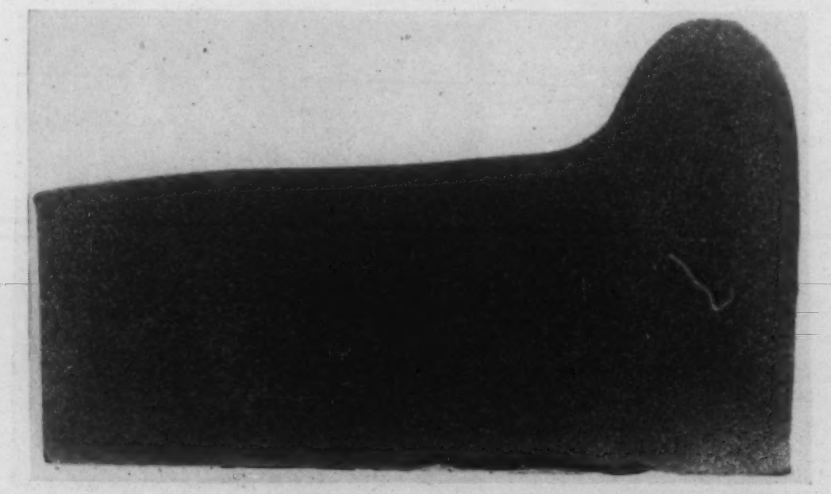


Fig. 15. Tire which Failed from being Nicked in the Bore with an Acetylene Torch. Etched with Ammonium Persulphate. Approx. ½ size.

of interest as showing the general trend of tire failures. Shelled tires have been omitted as no accurate record of them was available. Many are never reported, the shelled metal is machined off, if possible, and the tire returned to service. Judging from the number that are sent in and the reports of the shop foremen the number of shelled tires in the same period that is covered in this classification would exceed the total of other tire failures.

Classification

Number of tires with steel defects	12
Progressive fractures originating in a heat checked flange	11
Snap breaks	7
Progressive fractures beginning in the bore	
A. Beginning on the flange side of the bore	11
B. Beginning near the center of the bore	3
Miscellaneous failures	
A. Nicked in the bore with an acetylene torch (see Fig. 15)	1
B. * Built up flange	1
C. Heat checked tread (tire slid flat)	1
Total Failures	47

* Building up the flange of worn tires with an acetylene torch has not been practiced on the Milwaukee Road for many years. It is not known how this one happened to be in service.

Further in connection with these failures it is interesting to note the composition with respect to the carbon content. Discarding the defective tires and the two that failed from the heat effect of a torch leaves 33 tires. Of these only 6 had more than 0.70% C, the upper limit for Grade A tires, and only 3 of these had more than 0.72% C. Of the other 27 tires two had less than 0.60% C. There were, therefore, 25 tires or 76% of the failures in the upper half of the carbon range of Grade A tires. Only 9% of the failures had a carbon content as high as the upper fourth of the carbon range for Grade B tires. This appears to be good evidence that 0.60-0.70% C is too low for heavy duty tires. Whether or not the presence of free ferrite has a bearing on this, as suggested above, it is not easy to prove but at least the evidence does indicate that freight engines require as high carbon tires as do passenger engines. It is the opinion of the author that both of these classes of engines should have tires made in a carbon range of approximately 0.70-0.80%. This would bring them into about the same carbon range as is found in rails and rolled steel wheels.

Modified Mountain Type Oil Burning Locomotive

Acknowledgment

The author is greatly indebted to Mr. A. G. Hoppe, Engineer of Tests, of the Milwaukee Road, for the numerous suggestions and constructive criticism he has contributed to this study. Other members of the Mechanical Department have assisted in this work and their coöperation is gratefully acknowledged.

The Age-Hardening Characteristics of Some Copper-Nickel-Silicon Alloys

By Bruce W. Gonser and L. R. van Wert*

(Continued from November, 1934, issue)

The Effect of Cold Work

In these investigations the effect of cold work was followed by direct tests simulating commercial methods of working (as by drawing, rolling, swaging and compression) and by a more indirect method of measuring the hardness produced by a standard 10 mm. Brinell ball impression under 1000 kg. pressure both before and after age-hardening by heat. The latter method because of its great convenience, quickness and ease of application to all specimens was used most extensively. By skill in practice general dependable results were secured which could be checked to within a point on the Rockwell scale. This Rockwell-in-Brinell method of testing has been fully described by Sauveur and Burns.[8]

Figs. 12-18 give comparisons of the hardness obtained by normal aging and when preceded or followed by cold work. The principal observations made from these and other tests on the effect of cold work are:

1. Greatly increased hardness when worked from solution annealed condition.
2. Accelerated rate of age-hardening by heat after cold work.
3. Comparatively rapid decrease in hardness of material cold worked, then overaged.
4. Greatly increased hardness of material cold worked after heat aging.
5. Gradual decrease of additional hardness produced by cold work after aging with time or increased temperature.

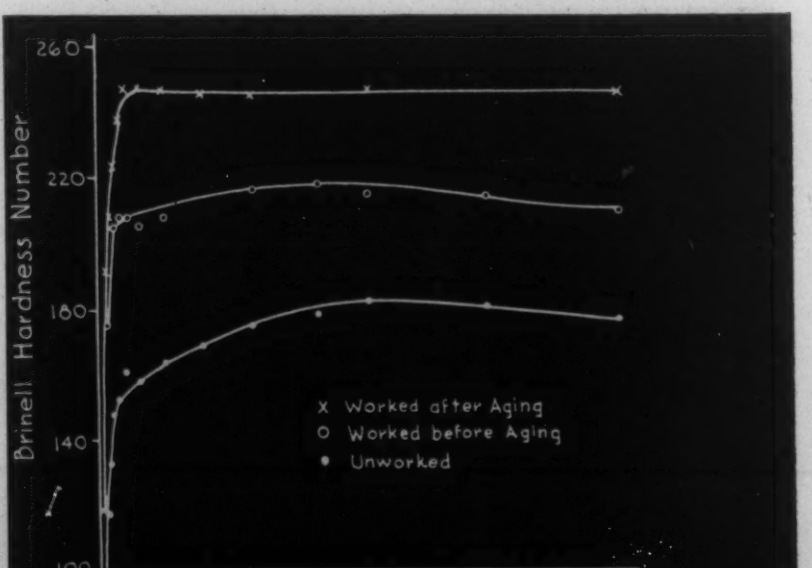
Some of the variations from the normal work hardening effect are undoubtedly due to grain growth and to strain relief. Conclusive evidence of any simultaneous age-hardening forced by work at room temperature is lacking. However, there is reason to believe that the mechanical structure change due to cold working the annealed alloy favors or accelerates subsequent age-hardening by heat treatment. This is to be expected since distortion of the lattice structure by cold work should encourage migration of solute atoms and favor ease of diffusion. Since the lattice energy is increased less external energy would be needed to effect a phase change. Results of the tests on age-hardening after cold work invariably showed a more rapid rate of hardening and decline after reaching maximum hardness when aging followed cold work. This would indicate increased ease of age-hardening caused by cold work. Strain relief also plays a part and the hardness obtained is probably a balance between several counteracting factors.

Work after age-hardening in general merely adds a fairly definite additional hardness presumably due to work strain. It is possible, however, that some additional age-hardening action could take place since an alloy aged at a comparatively high temperature, as 500° C., then cooled, would theoretically retain in a supersaturated condition solute equivalent to the difference in solubility between the 2 temperatures. There is no way of telling whether any additional age-hardening simultaneously accompanies final cold work but the data of Table 8 indicates that an increased tension or potential hardening condition is established. By application of heat slight additional hardness is gained which can best be attributed to promotion of an age-hardening condition. At a temperature above 300° softening by strain relief apparently equals of exceeds any tendency for additional hardening by aging conditions forced by cold work. This is in agreement with results of similar tests made by Ellis and Schumacher[5] on the effect of low temperature aging upon the tensile strength.

Behavior Under Torsional Stress

Using a torsion machine for twisting specimens under a constantly increasing load as described by Dr. L. R. van

Fig. 12. Effect of Cold Work; Series C Alloy. Age-hardened at 450° C.



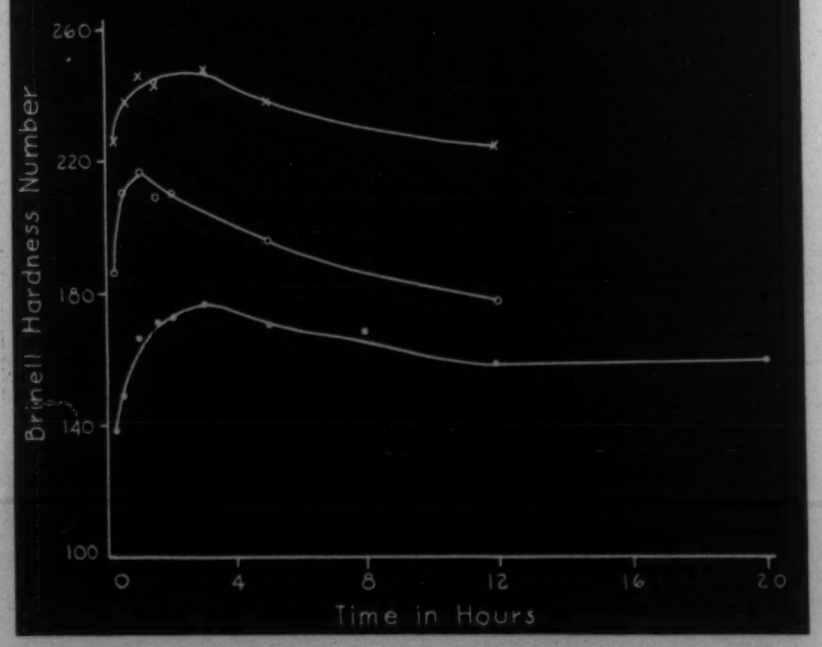


Fig. 13. Effect of Cold Work; Series C Alloy. Age-hardened at 500° C.

* Lecturer on Metallurgy, Harvard University.

Table 8. Effect of Reheating Series C Alloy after Age-hardening and Cold Working

Solution Anneal 1 hr., 800° Brinell	Heat aged 1 hr., 525° Brinell	Worked after aging Brinell	Reheated, 1 hr. Temp. °C.	Reheated, 1 hr. Hardness Gain Brinell
53	172	262	100	3
53	171	258	150	6.5
53	172	259	200	5
53	172	258	250	3
54	172	258	300	0
54	172	258	400	—9
56*	181*	256	525	—26

* Solution anneal at 775°; heat aged 30 hours at 450°.

Wert,[9] it was found that the sharpest "steps" or interruptions in the stress-time diagrams took place at 200°-300° for the Series C alloy and 300°-400° for Series A alloy. More sloping or less definite pauses took place before and after these temperatures; none at all at 600°, and none or very indefinite ones from fully age-hardened material at any temperature.

This modification (of the usual relatively smooth yielding of metal by increasing stress beyond the elastic limit) which takes place only when twisting the unaged material suggests a relationship between aging and work—possibly some simultaneous strengthening due to age-hardening as well as to work, especially at elevated temperatures. The sharpest arrests to torsion slip occur at temperatures considerably lower than where age-hardening alone is rapid but this is in accordance with evidence throughout indicating that work hastens the speed or lowers the temperature of subsequent age-hardening.

Summarized Electrical Conductivity, Dilatometric, Metallographic and X-Ray Results.

Results of conductivity tests in these investigations agreed in general with those secured by Wilson, Silliman and Little.[6]

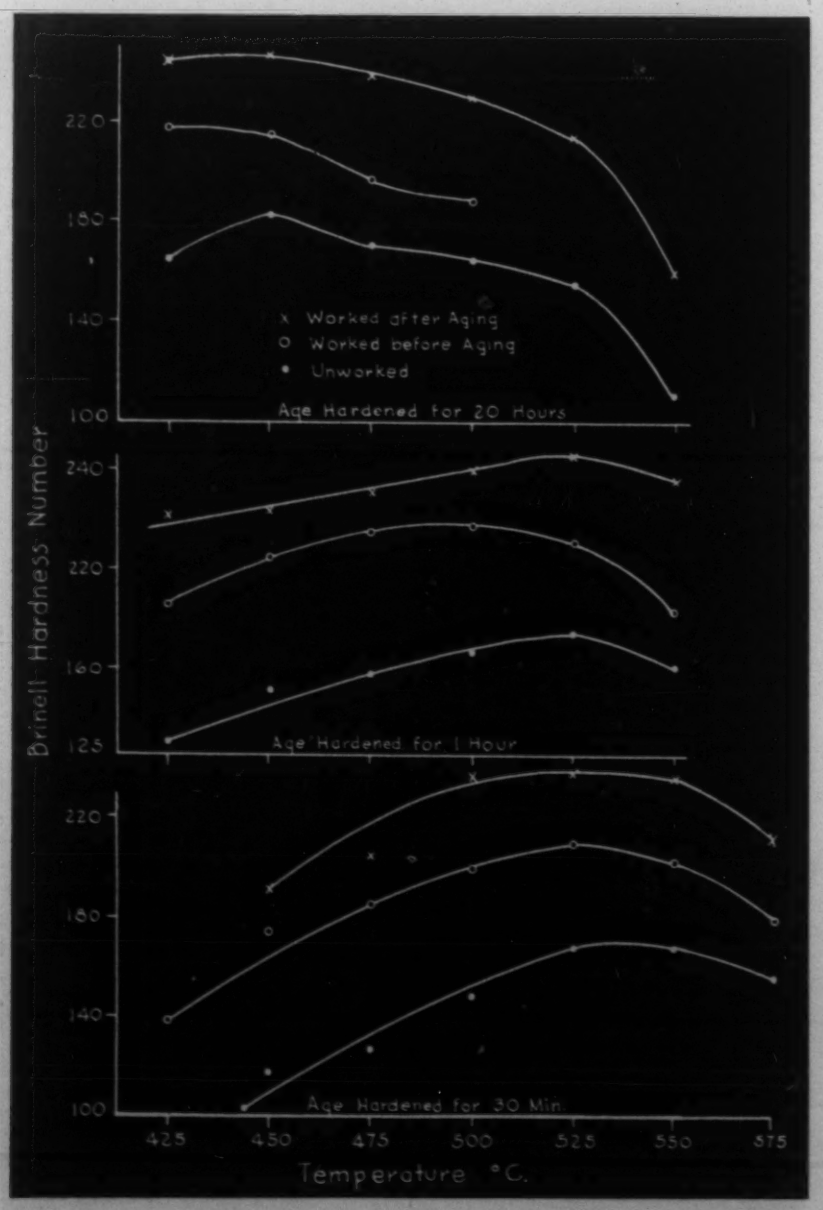


Fig. 14 (Top). Effect of Cold Work; Series C Alloy. Age-hardened for 20 Hours.

Fig. 15 (Center). Effect of Cold Work; Series C Alloy. Age-hardened for 1 Hour.

Fig. 16 (Bottom). Effect of Cold Work; Series C Alloy. Age-hardened for 30 min.

Fig. 17. Effect of Cold Work; Series A Alloy. Age-hardened at 500° C.

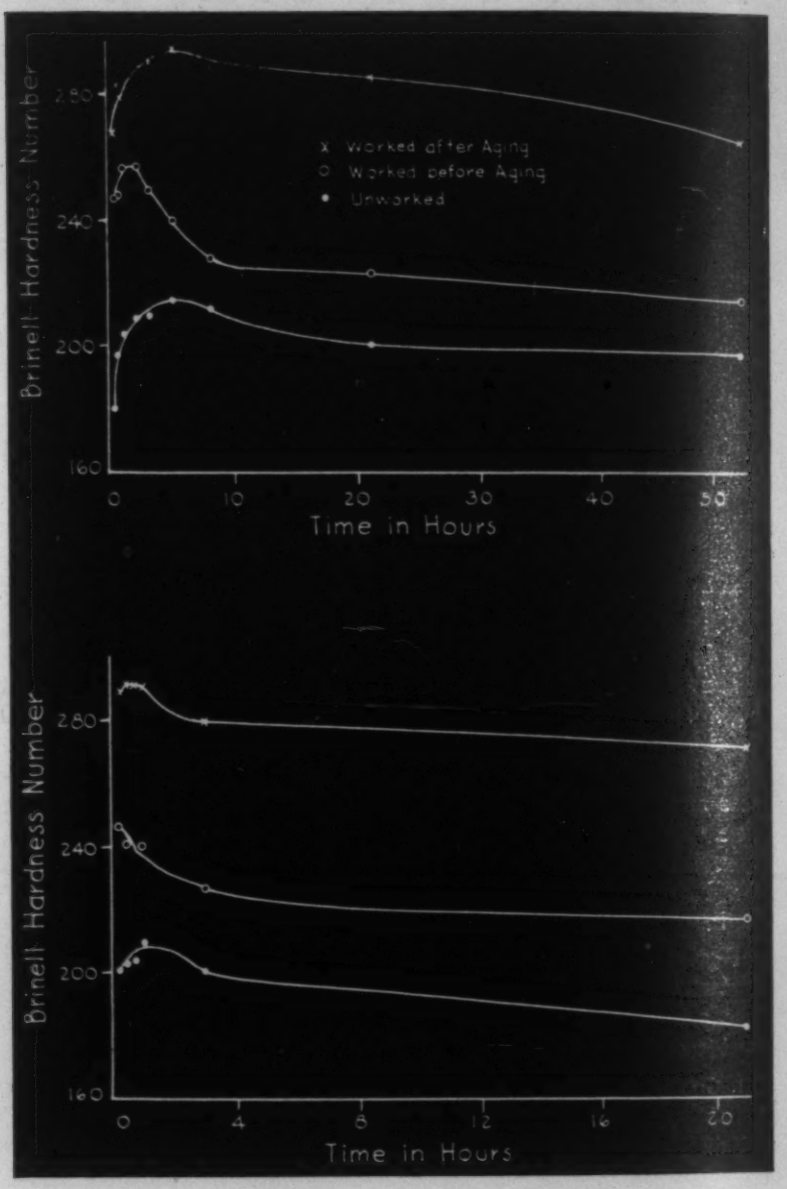


Fig. 18. Effect of Cold Work; Series A Alloy. Age-hardened at 550° C.

Table 9 gives briefly the general effect on electrical conductivity of various treatments.

Cold work alone results in some loss of conductance. Since age-hardening greatly increases the conductivity it is evident that there is little or no normal aging induced by work at room temperature.

The furnace annealed specimens may be considered to have had an overaging treatment at 700° as well as an opportunity for complete divorcement of all excess solute as the specimens were slowly cooled. The relatively low conductance secured under these conditions as compared with specimens

Table 9. Effect of Aging Treatment on Conductance

Condition	Heat Treatment hrs.	Heat Treatment °C.	Brinell	% Conductance of Copper
	Series B Alloy; 3% Ni_2Si			
Solution Annealed	1	830	56	18.27
Cold Worked	68% Reduction		131	17.8*
Partly Aged	0.33	450	142	30.13
Fully Aged	2	510	173	40.96
Overaged	19	580	113	42.20
Furnace Annealed	1	800		
	8	700	85	34.27
	10.5	700–100		
	Series A Alloy; 5% Ni_2Si 5.3% Al			
Solution Annealed	1	900	67	7.98
Cold Worked	70% Reduction		234	7.09
Partly Aged	0.33	450	162	11.30
Fully Aged	2	525	214	12.07
Overaged	19	580	174	12.77
Furnace Annealed	1	900		
	1	800		
	8	700	106	11.67
	10.5	700–100		

overaged at temperatures of 580° or less indicate a different kind of precipitation at the 2 temperatures or a change in solubility or chemical combinations as suggested in the discussion of overaging, page 253. The suggestion may be

made that at the lower temperature molecular groups of nickel silicide with or without actual precipitation may take place, whereas at the higher temperature a more complex combination of nickel, silicon and copper may exist. This could explain the reduced conductivity when heated at the higher temperature as well as differences in structure as determined metallographically.

Dilatometric diagrams indicate a rather irregular tendency for volume decrease during the lower age-hardening temperatures, then marked expansion between about 580° and 740° for the Series C Alloy. At a temperature where the solid solution is again formed from the aged alloy volume contraction results. The cooling curves where free precipitation of excess solute should take place show a break in the rate of volume change at about 520°-540°. This coincides fairly well with the temperature at which the anomaly in conductivity measurements was found.

Metallographic work with Series C alloy showed no indication of the presence of precipitated particles or separation of a second phase after aging to maximum hardness. On long overaging at 550°, however, the presence of particles of a second phase was found.

Laue diagrams showed asterism striations indicative of lattice strain after aging to maximum hardness, no strain in the solution annealed condition and but relatively small strain when slowly cooled to permit free precipitation.

X-ray diffraction patterns showed unknown lines which could belong to a precipitated compound only with specimens overaged or agglomerated at 700° and when slowly cooled from a solution annealing temperature. Diffraction line measurements of Series C alloy indicated a slight decrease in the copper parameter when nickel and silicon were dissolved, no very appreciable change when aging to maximum hardness and an actual small expansion of the lattice after aging for 68 hours at 550°. The indications checked those of the dilatometric and other tests. However, for positive quantitative determinations in detecting these small differences in lattice parameter the back reflection method of taking x-ray patterns is necessary.

Summarizing, the effect on hardness of heat treatment and combinations of heat treatment and work before and during age-hardening has been traced over a fairly wide range of time and temperature. A change which takes place between 500° and 700° (first noted by Wilson, Silliman and Little from conductivity measurements) was verified by reaging specimens which had been overaged at a higher temperature and was further confirmed by conductivity, dilatometric, metallographic and x-ray examinations. The exact nature of this change has not yet been determined.

Grateful acknowledgment is made to Professor Albert Sauveur and Mr. John Burns of the Harvard Department of Metallurgy for encouragement and assistance given throughout this investigation and to the American Brass Company for furnishing the alloys used in the experimental work.

Personnel Changes at Duriron

Wm. E. Hall, President of The Duriron Company, Inc. of Dayton, Ohio, has announced the appointment of M. L. Bettcher, formerly General Superintendent, to the position of General Manager, succeeding Dudley H. Miller, who becomes Executive Vice-President. Mr. Bettcher is a graduate Mechanical Engineer of New York University. He joined the Duriron organization in January, 1920 shortly after being discharged from the Army. He served overseas as an officer in the 309th Engineers. He started his work with The Duriron Company as a salesman in the Chicago District and later was transferred to the Manufacturing Department at the Plant and General Offices in Dayton.

N. E. Philpot, who has been manager of the Chicago Office for several years, is assuming charge of the New York Office, succeeding W. E. Pratt, resigned. Col. M. W. Smith, formerly manager at Buffalo, is taking over the Chicago Office. W. A. Watkins, has been transferred from the General Sales Department at Dayton to Buffalo as manager.

A.S.M. Pittsburgh Chapter Courses

The Pittsburgh Chapter of the American Society for Metals will offer this winter, three short courses in Metallurgy. The object of these educational courses is to increase the membership of the Pittsburgh Chapter.

Following are the courses and the dates of presentation: Heat Treatment of Steel to be given by Dr. F. H. Allison, Crucible Steel Co. of America. January 15th, January 22nd, January 29th, February 5th, February 12th. Manufacture of Steel in the Open Hearth to be given by Mr. Max Lightner, Carnegie Steel Co. February 26th, March 5th, March 12th, March 19th, March 26th.

New Revere Office

Revere Copper and Brass Incorporated announces the opening of an office at 804 Tower Petroleum Building, 1905 Elm Street, Dallas, Texas.

Batcheller Elected Bank Director

Hiland G. Batcheller, President of Ludlum Steel Co., was elected to the Directorate of the New York State National Bank, Albany, N. Y., one of the oldest banks in the country. Founded in 1804 it has continuously to date done business on the same site.

Stainless Steel Castings Co.

Leo G. Smith is president of the recently organized Stainless Steel Castings Co. of America, Inc., Milwaukee, Wis. The company will make carbon, stainless and other alloy steel castings.

Ohio Ferro-Alloys' Sales Manager

The Ohio Ferro-Alloys Corporation, Canton, Ohio, announce the appointment, effective as of November 1st, 1934, of Geo. W. Starr as General Manager of Sales. Mr. Starr, throughout his business life, has been closely indentified with the iron and steel industry and his many friends and acquaintances will recall his long association with the United Alloy Steel Corporation as Director of Purchases, now a unit of The Republic Steel Corporation.

Dr. Vsevolod N. Krivobok, professor of metallurgy at the Carnegie Institute of Technology, recently associated himself with the Research Dept. of the Allegheny Steel Company at Brackenridge, Pa. Dr. Krivobok will divide his time equally hereafter between these two institutions.

Paul H. Shaeffer has been appointed, effective November 1st, 1934, Assistant General Manager of Sales of the Ohio Ferro-Alloys Corporation, Canton, Ohio. Mr. Shaeffer has been prominently identified with the progress and development in the alloy steel industry, and has had many years of practical steel making experience, primarily through association with the Central Steel Company, Massillon, Ohio, and through United Alloy Steel Corporation, Canton, Ohio, now units of Republic Steel Corporation.

E. P. Polushkin has joined the staff of Lucius Pitkin, Inc., as Associate Metallurgist, with particular reference to Research and Development. Mr. Polushkin was formerly Instructor in Metallography at the School of Mines, Columbia University, and Lecturer on Dental Metallurgy at the School of Dentistry.

John Frederick Kelly, managing director of the Association of Iron and Steel Electrical Engineers and editor of the "Iron and Steel Engineer" since 1917, died Nov. 17th in his home, 1326 Rockland avenue, Beechview, from a cerebral hemorrhage. Mr. Kelly was born in McKeesport and lived in the Pittsburgh district all his life. He was assistant superintendent of the electrical department of the National Tube Company at McKeesport before he founded the publication of which he was editor. He was a member of the American Academy of Political and Social Science, the American Naval Institute, and the American Iron and Steel Institute.

Plastic Deformation at a Hole in Steel and Magnesium Alloy Plates

By R. H. Heyer* and R. H. Burns**

THERE is a growing body of evidence that the manner in which a material responds to the presence of stress raisers will greatly affect its suitability for many uses. Particularly in repeated stress have various degrees of sensitiveness to stress concentration been noted. This paper attacks the problem in a different and enlightening manner.

Elastic theory and photoelastic tests deal mainly with stresses below the elastic limit, but actual damage generally occurs only at higher stresses. Experimental studies usually are confined to conditions causing fracture. The authors have adapted an old method of investigation to the determination of local small permanent deformations near a hole.

It would be instructive to examine a group of materials having different types of stress-strain diagrams by this method, and to draw broader conclusions as to their behavior. Perhaps such a criterion would alter our general ideas of the sort of material that would behave well, when, for example, it contains bolt-holes under heavy stress.

Prof. H. F. Moore remarked on reading this manuscript that "it takes us on a little journey into that region of localized plasticity where we expect that many of our failures of metal machine parts originate." It suggests the existence of another kind of ductility from that we ordinarily measure.

●

STRESS CONCENTRATIONS are attracting increasing attention in engineering design. Analyses by the methods of the theory of elasticity and by photoelastic means frequently reveal dangerous local conditions which are not indicated by the commonly used methods of calculation. In members subjected to repeated stress, and repeated stress with corrosion, the danger is particularly imminent. In the case of static or nearly constant loading it is frequently a question how much importance to place on small highly stressed areas when the structure as a whole can easily withstand the applied loads. Where constancy of dimensions is desired, stress concentrations should not be overlooked.

A particular case of stress concentration was chosen for this investigation. The analysis of the elastic conditions in a tensile member drilled or punched for fastening or other purposes was first made by Prof. G. Kirsch.[1] His results have been checked experimentally, both by observation of the actual deformations in metal plates and more recently by photoelastic methods. A careful experimental determination of this stress concentration ratio in steel plates was made by E. Preuss.[2] In this work he used a Marten's mirror type of extensometer having a gage length of 3.3 mm. Using a ratio of width of plate to hole diameter of 8, he was able to measure a maximum stress concentration at the hole of 2.35. According to the calculations made below, the theoretical factor is about 2.74 taking into consideration the geometrical proportions of his test specimen and gage length. Considering the experimental difficulties in using such a short gage length, the error is not unreasonable. Coker and Filon[3] report an investigation by Y. Satake at University College in which extensometer measurements were made on a steel plate. In this case the lateral contraction in thickness of the plate was measured, making it possible to confine the entire gage distance to the region of maximum stress concentration. Although the plate was nearly ½" thick, the Poisson effect reduced the contractions to a very small order. Nevertheless, the stresses measured were only slightly under the theoretical values. It is now widely accepted that at the point of high stress (see Fig. 1, point P) the material reaches its elastic limit when the average stress in the gross section herein denoted by (M←→M) is only 1/3 of its elastic limit. In other words, the factor of concentration is 3. The general equations follow from which the stresses at any point in the plate may be calculated.[4]

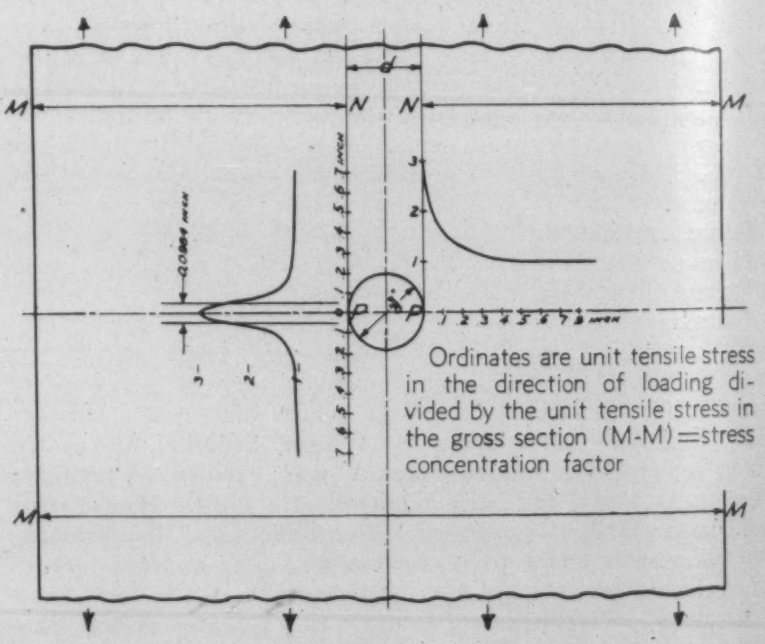

d
M
N
N
M
P
Ordinates are unit tensile stress in the direction of loading divided by the unit tensile stress in the gross section (M-M) = stress concentration factor

Fig. 1.

$$\sigma_r = \frac{S}{2}\left(1-\frac{a^2}{r^2}\right) + \frac{S}{2}\left(1+\frac{3a^4}{r^4}-\frac{4a^2}{r^2}\right)\cos 2\theta$$

$$\sigma_\theta = \frac{S}{2}\left(1+\frac{a^2}{r^2}\right) - \frac{S}{2}\left(1+\frac{3a^4}{r^4}\right)\cos 2\theta$$

$$t_{r\theta} = -\frac{S}{2}\left(1-\frac{3a^4}{r^4}+\frac{2a^2}{r^2}\right)\sin 2\theta$$

σ_r = unit stress in radial direction
σ_θ = unit stress in tangential direction
$t_{r\theta}$ = unit sheer stress
S = unit stress in a gross section removed from the hole
r = distance from center of hole along a radius vector
a = radius of hole
θ = angle made by the radius vector and the direction of external tension

* Purdue University.
** Presented as an undergraduate thesis at Purdue University.

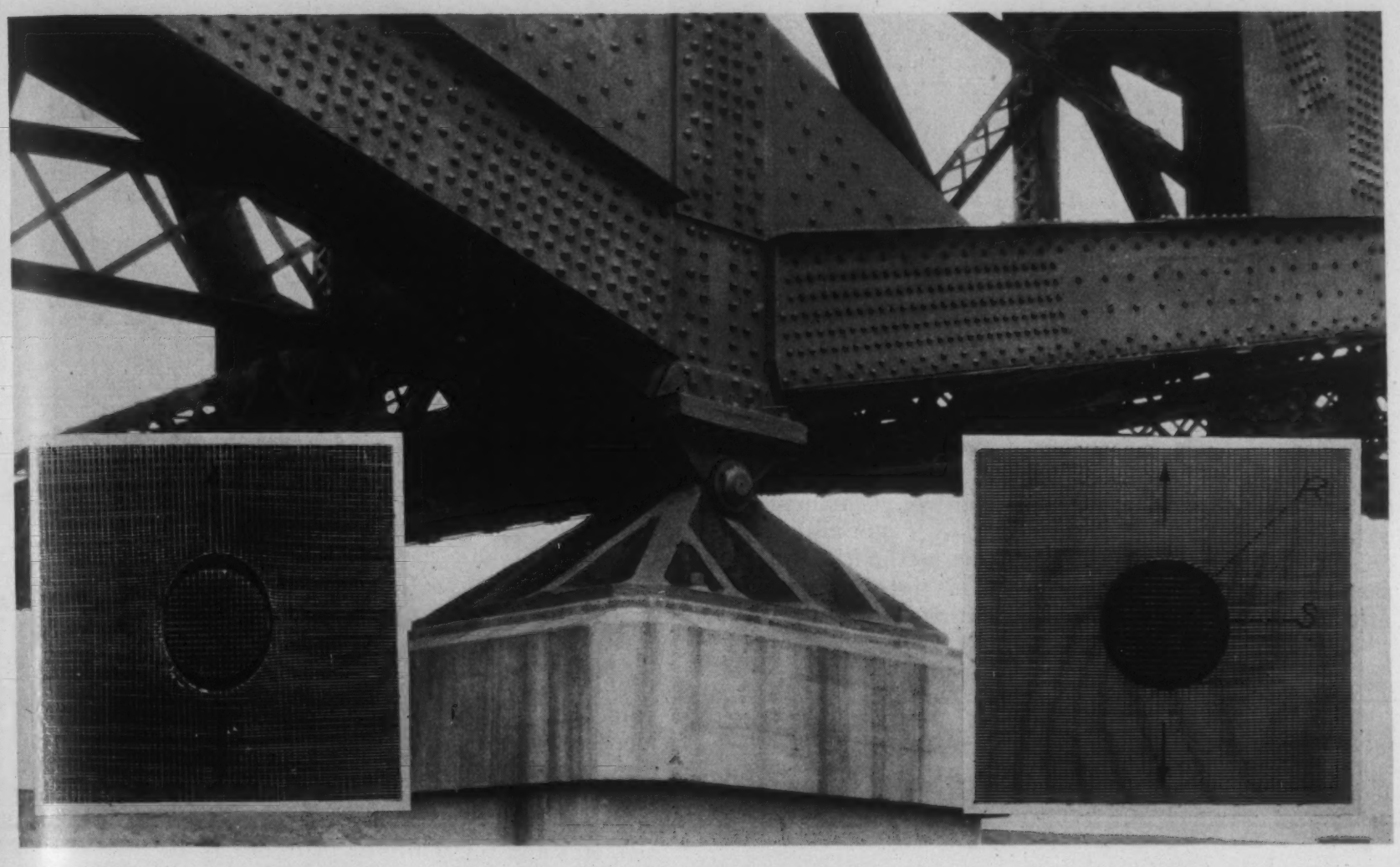


Fig. 3. Steel. Ratio of average stress in net section to yield strength = 1.14. 2 ×

Gusset connection and riveting at the shoe for a viaduct recently erected.
(*Courtesy American Bridge Company*)

Fig. 4. Dowmetal. Ratio of average stress in net section to yield strength = 1.25. 2 ×

Photoelastic investigations have established the further condition that the ratio $\frac{M\longleftrightarrow M}{d}$ (see Fig. 1) must be 8 or over for application of these formulae. The concentration factor diminishes for narrower plates according to the following experimentally determined relation which holds for $\frac{M\longleftrightarrow M}{d}$ equal to 1.5-8.0:[5,6]

$$\frac{\sigma(\text{maximum})}{\sigma(\text{net section})} = 3.0 - \frac{1.6(8.0 - M\longleftrightarrow M/d)^{3.6}}{1100}$$

Other photoelastic determinations are in substantial agreement with respect to the elastic conditions about the hole.[7,8,9,10]

Object

This report is a preliminary treatment of the subject of plastic flow of the metal in the region of a hole in a tensile member stressed beyond the point of local yielding. Two metals were chosen having different plastic characteristics as indicated by their respective stress-strain relationships. Certain conclusions are drawn based on their different action in the critical region. It is anticipated that further work will be possible using other common structural metals and using certain metals in different stages of cold work and heat treatment.

Materials Used

⅜" hot rolled mild steel plate and ⅜" rolled Dowmetal F were the two test materials. The steel

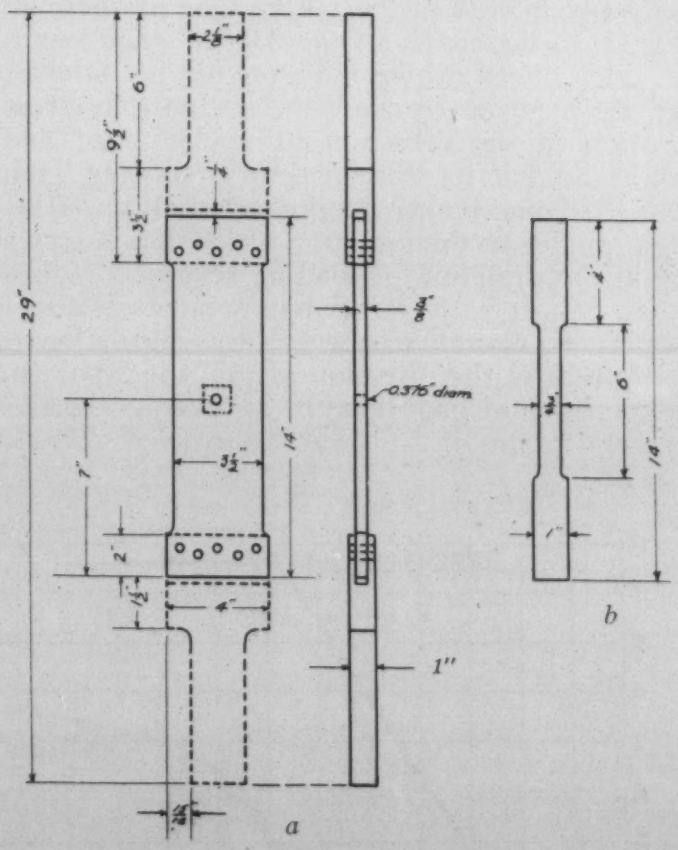


Fig. 2.

was normalized for 20 minutes at 1550°F., and the Dowmetal was used as rolled.

Experimental Procedure

The yield strengths (see Fig. 5) of the two metals were determined on specimens as illustrated in Fig. 2b, using 4 Huggenberger Tensometers set at one inch gage lengths. The yield strengths were based on 0.1% deviation from the modulus line. The sensitivity of

these gages permits reading to 0.00001". The special deformation tests were made on polished specimens scored in a metrically calibrated dividing engine as indicated in Figs. 3 and 4 at 2X. The ratios $\frac{M \longleftrightarrow M}{d}$ were 9.3 and 8.7 for Dowmetal and steel respectively. The smallest divisions were originally 0.0984" (0.25 mm.). A Monel Metal standard was inserted loosely in the hole. Four Huggenberger gages were again used to check the uniformity of loading. A standard mechanical type of universal testing machine of 50,000 lbs. capacity was used. Suitable increments of load were applied, after which the load was released and photographic negatives were taken at 2×. Lantern slides made from these negatives were projected at a total magnification of 40× and measurements made at the gage lengths to be defined later. A permanent set of .001" appeared as very slightly over one millimeter on the projected image. While this method is entirely inadequate for measuring elastic deformations, it offers wide latitude in the evaluation of plastic flow.

Table I

	Permanent Set	Average Stress at Net Section	Effective Yield Strength, lbs./in.²	Ratio of Stress in Net Section to Yield Strength, × 100
Steel	1.6%	37,200	37,200	100%
Dowmetal	0.9%	23,800	23,800	100%
Steel	1.0%	31,500	37,200	85%
Dowmetal	1.0%	24,350	23,800	102%

Discussion

It should be remembered that the analytical method of attack indicates a stress concentration factor of 3 at only two points in the plate. One of these is point P, Fig. 1, in the center of the 0.0984" gage length used here. Fig. 1 was drawn with the aid of the preceding equations in order to show the decrease in stress concentration in the direction of applied load and also at right angles to this direction, starting from the points P of maximum stress concentration. The drop at right angles to the direction of loading is very sharp, while in the direction of loading relatively high tensile stresses persist to a somewhat greater distance from the point of maximum stress. By calculation of the tensile stress in the direction of pull for 5 points along the experimental gage length, an average tensile concentration factor of 2.61 was determined. This factor

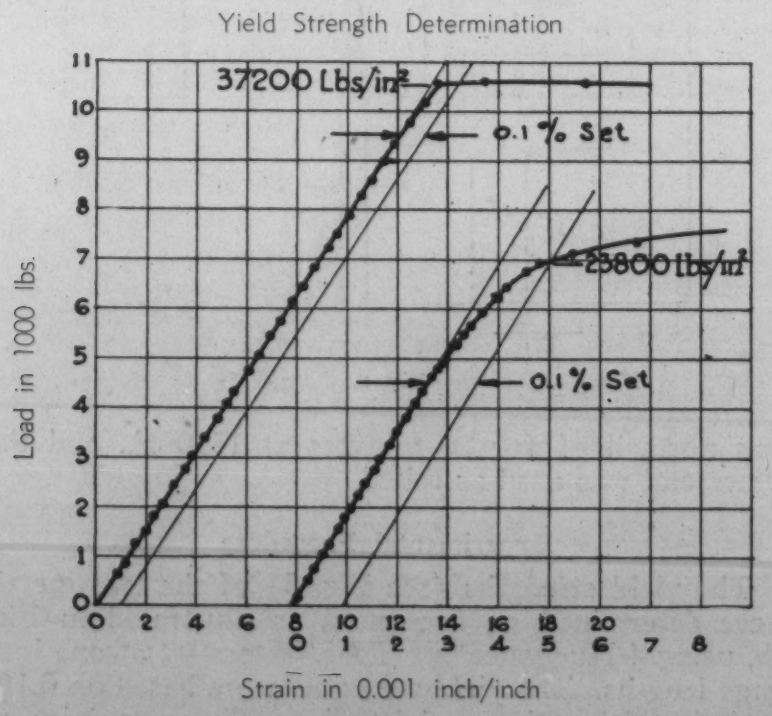


Fig. 5.

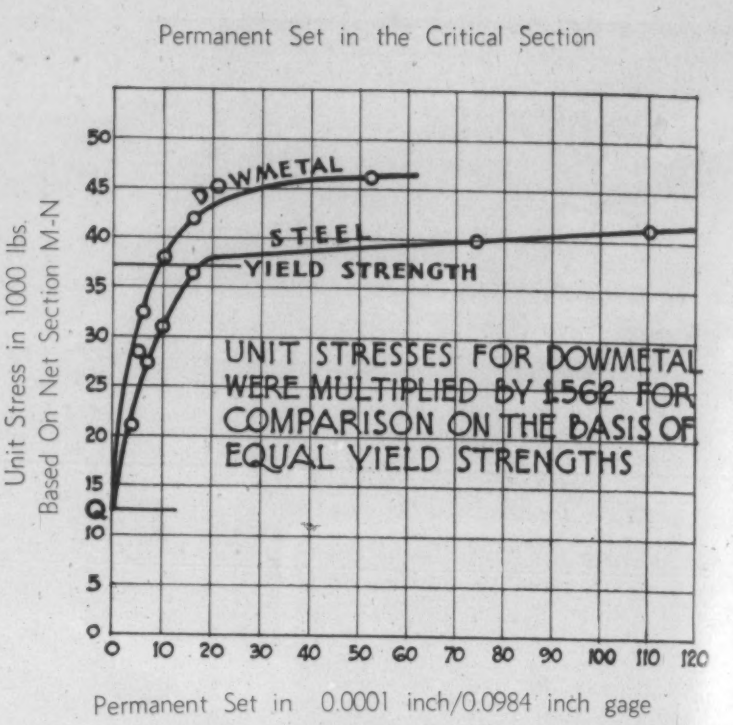

Permanent Set in the Critical Section
DOWMETAL
STEEL
YIELD STRENGTH
UNIT STRESSES FOR DOWMETAL WERE MULTIPLIED BY 1.562 FOR COMPARISON ON THE BASIS OF EQUAL YIELD STRENGTHS
Unit Stress in 1000 lbs. Based On Net Section M-N
Permanent Set in 0.0001 inch/0.0984 inch gage

Fig. 6.

should be used in place of 3.0 in considering the above data. It might be noted that if the gage length were increased from 0.0984" to 0.5", a Huggenberger strain gage could be used to detect the beginning of plastic flow. In order to keep the concentration factor as high as 2.61, the hole should then be nearly 2" in diameter and the width of plate nearly 16".

In Fig. 6 the permanent deformations in the 0.0984" gage length are plotted against the unit stresses in the net sections. In order to compare fundamental characteristics instead of absolute strengths, the unit stress scale for Dowmetal was expanded until the yield strengths coincided.

Line Q on Fig. 6 was obtained as follows:

$$\frac{\text{Yield strength} \times \text{Area of net section}}{\text{Area of gross section} \times \text{Av. stress conc. factor at P}} = \frac{37{,}200 \times 1.047}{1.183 \times 2.61} = 12{,}600 \text{ lbs. / in.}^2 \text{ Av. yield}$$

stress in the 0.0984" gage length.

Since the curves are plotted in terms of stresses at *net* sections, and since the analytical factor 3 is based on the *gross* section, the above conversion was necessary to obtain Q. When the entire net section was loaded to its yield strength, the deformations were 1.6% and 0.9% for steel and Dowmetal respectively (see Table I). At a permanent set of 1% in the critical section the steel carried 85% of its yield strength load and the Dowmetal 102%. It is apparent from the curves that the Dowmetal can carry the concentrated load with less plastic deformation than the steel, remembering that the comparison is made on the basis of equalized yield strength. The plastic characteristics observed in the original stress-strain curves (Fig. 5) appear to be reflected in these special deformations at the region of high stress. The foregoing data are not experimental proof of the theoretical 3:1 stress concentration ratio, but are consistent with such an analysis which prescribes, as shown above, that the first appreciable permanent set should occur at a unit stress of 12,600 lbs./in.²

Visual evidence of the increased distortion of the steel is to be found by comparing Figs. 3 and 4.

Fig. 7 was plotted from data obtained from a num-

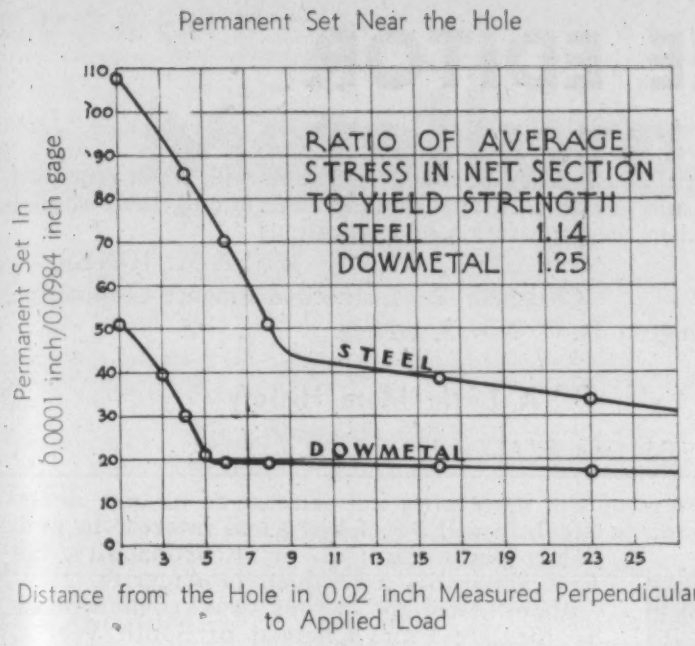

Permanent Set Near the Hole
Permanent Set In 0.0001 inch/0.0984 inch gage
RATIO OF AVERAGE STRESS IN NET SECTION TO YIELD STRENGTH
STEEL 1.14
DOWMETAL 1.25
STEEL
DOWMETAL
Distance from the Hole in 0.02 inch Measured Perpendicular to Applied Load

Fig. 7

ber of 0.0984" gage lengths along the extension of a diameter perpendicular to the direction of pull. The measurements were taken from lantern slides corresponding to Figs. 3 and 4, representing the maximum applied loads in each case. Here again the steel shows greatest deformation at all gage lengths measured, even though the Dowmetal was loaded to a greater percent of its yield strength. Further analysis of these curves requires a treatment of the possible modes of elastic failure.

A tensile member may fail in tension, or more commonly in shear or by a combination of shear and tension. In the case of the steel plate there were certain surface indications of yielding. The characteristic formation of Luder's lines appeared first at right angles to the directions of applied stress and developed from the points of maximum stress concentrations to the edges of the plate. With slight increases in load the shear lines appeared at approximately 45° to the directions of applied stress and progressed from the highly stressed points to the edges of the plate. In the case of Dowmetal, no such surface alterations were observed.

One published picture of Luder's lines about a hole in a steel plate showed similar lines at right angles to the applied force. Other indications in the literature point to deformation along the 45° shear lines as the common method of failure. Fig. 7 and other considerations suggested that the Dowmetal deformed mainly in this latter manner in such a way that gage lengths beyond 0.12 inch from the edge of the hole were outside the zone of drastic movement. In the region of maximum shear (see R in Fig. 4) the measured set for Dowmetal was greater than at S at right angles to the load. Similar measurements on the final steel picture showed these deformations to be nearly identical. Although no picture of the steel plate was available after formation of the right angled Luder's lines only, it would undoubtedly have shown the opposite tendency displayed by the Dowmetal—S greater than R.

This part of the problem is apparently concerned with the relative strengths of the metals under tensile and shear conditions. More fundamental work along this line is now under way at Purdue University.

The writers wish to express their indebtedness to Prof. S. C. Hollister for his suggestions during the course of this work. The Dowmetal plate was supplied by the Dow Chemical Company, Midland, Mich.

Conclusions

1. The order of magnitude of the localized permanent set at a hole in a plate may be considered as being less than 2% elongation when the net section of the plate is stressed up to its yield strength.
2. In the cases of metals with gradually yielding stress-strain characteristics, this set may be less than 1%.
3. Drastic yielding in the critical section occurs only when the entire net section is stressed beyond its yield strength.
4. The entire mechanics of failure may depend on certain elastic and plastic properties of the metal, which differ in different metals and alloys.

References

[1]G. Kirsch. Die Theorie der Elasticität und die Bedürfnisse der Festigkeitlehre. *Zeitschrift des Vereines deutscher Ingenieure*, Vol. 42, 1898, pages 797-807.
[2]E. Preuss. Versuche über die Spannungsverteilung in gelochten Zugstäben. *Zeitschrift des Vereines deutscher Ingenieure*, Vol. 56, 1912, pages 1780-1783.
[3]E. G. Coker & L. N. G. Filon. Photoelasticity. Cambridge University Press, 1931, pages 481-489.
[4]S. Timoshenko. Theory of Elasticity. McGraw-Hill Book Co., 1934, pages 75-80.
[5]G. J. Schoessow. Thesis No. 7860. Purdue University, 1933.
[6]S. C. Hollister & G. J. Schoessow. Stress Concentration at a Circular Hole in a Plate in Monaxial Tension. *Physical Review*, Vol. 44 (2nd series), No. 4, 1933, page 330, Abstract No. 81.
[7]R. C. J. Howland. On the Stresses in the Neighborhood of a Circular Hole in a Strip under Tension. *Philosophical Transactions*, A, Vol. 219, 1930, pages 49-86.
[8]A. Henning. Polarisationsoptische Spannungsuntersuchungen am gelochten Zugstab und am Nietloch. *Forschung aus dem Gobiete des Ingenieurwesens*, Vol. 4, No. 2, 1933, pages 53-65.
[9]A. M. Wahl & R. Beeuwkes. Stress Concentration Produced by Holes and Notches. *Product Engineering*, Vol. 5, 1934, pages 92-94.
[10]A. Nadai. Plasticity. McGraw-Hill Book Co., 1931, pages 100-103.

Welding Exhibit for Museum of Science and Industry

Announcement is made by Mr. O. T. Kreusser, Director of the Museum of Science and Industry in Chicago, that complete equipment, including material handling hoist for a permanent exhibit of industrial welding has been presented to the institution by the Harnischfeger Corporation of Milwaukee, manufacturers of P&H-Hansen Arc Welders. This exhibit is of unusual interest because of the rapidly increasing use of arc welding in practically all lines of industry. The exhibit itself is an ingenious one, for with the demonstrations carried on behind a special colored glass, visitors are able to see at close range the technique employed in various types of welding without blinding glare. The Museum of Science and Industry in Chicago is the only institution of its kind in the United States with a permanent arc welding demonstration.

"Stainless Steel in the Dairy Industry," was the title of an address given by **C. C. Snyder,** Republic Steel Corp., Central Alloy Division, Massillon, Ohio, before the Pittsburgh Chapter of the Dairymen's Association, Thursday, November 8. A number of display pieces of Enduro Stainless Steel were exhibited at the meeting.

At a recent meeting of the American Society for Testing Materials, **Charles McKnight** of the International Nickel Co., Inc., was elected chairman of the committee on ferro-alloys. Mr. McKnight is also serving at the present time on committee A-I on steel and sub-committee VIII on steel castings and I on steel rails.

Thomas T. Watson, who joined the Metallurgical Department of Lukens Steel Company, Coatesville, Pa., in August, 1931, has been appointed Development and Service Metallurgist. He will be engaged principally in service and sales work in connection with Lukens Nickel-Clad Steel. Mr. Watson was born in Scotland thirty-five years ago and graduated in 1923 from the Royal Technical College in Glasgow with the degree of Associate of the R. T. C. Until 1925 he was Assistant Metallurgist at David Colville & Sons, the largest iron and steel manufacturer in Scotland. He then became Metallurgist at the Clyde Alloy Steel Company, serving there for two years under Dr. A. McCance, Managing Director. From 1927 to 1930 he was Assistant Metallurgist at Dorman Long & Company, one of the largest iron and steel manufacturers in England. He came to this country in 1930 and engaged as a Consulting Metallurgist in New York until he joined the Lukens organization in 1931.

LETTERS TO THE EDITOR

Reconstruction Finance Loans

Editor, METALS & ALLOYS:

Industrial concerns, eligible to borrow funds from the Reconstruction Finance Corporation for the purpose of maintaining and increasing employment, have not yet taken full advantage of the assistance which the Corporation is prepared to extend.

Congress provided that such loans might be made to industrial and commercial businesses subject to the following requirements:

(1) That the business must have been established prior to January 1, 1934.
(2) That such loans be adequately secured.
(3) That maturity of loan must not exceed five years.
(4) That borrower must be solvent at the time of disbursement of the loan.
(5) That credit at prevailing bank rates for loans of the character applied for not be available at banks.
(6) That reasonable assurance of increased or continued employment of labor be given.
(7) That the aggregate of such loans to any one borrower made directly or indirectly shall not exceed $500,000.
(8) That such other provisions as the Reconstruction Finance Corporation may impose be complied with.

The Directors of the Reconstruction Finance Corporation feel that these loans should be made in such a way that the available funds can be utllized as fully as possible for the advance of permanent business recovery. This objective can be accomplished best if the moneys loaned by the Corporation are used principally to supply funds for the payment of labor and the purchase of materials incident to the normal operation of the business, rather than for the payment of existing indebtedness, though in exceptional cases a small part of the loan may be used for payment of existing debts or for the financing of construction, improvements and/or repairs that do not materially increase capacity. When a loan is to be used primarily for labor and materials, a small portion of the loan may be applied to these latter purposes when necessary to assure ordinary and efficient operation.

The Corporation will make loans in coöperation with banks, or by the purchase of participations in loans made by banks. In cases of national banks, only the bank's participation in such loans, rather than the full amount of the loan, must be within the legal limit which may be loaned to any one customer, and accordingly this plan will allow substantially greater credit to be extended through such channels to borrowers who are already borrowing up to their legal limit.

The depression years have left many enterprises in very much involved and weakened positions, but our experience has led us to believe that where present creditors are willing to coöperate by a proper adjustment of existing debt structure, many such enterprises may be safely supplied with additional funds that will enable continuing operations on a sound basis.

Accordingly, we suggest to industrial concerns, to which credit at prevailing bank rates for loans of such character is not available but which can offer adequate security (even though such security may be frozen and therefore not generally acceptable to banks) and which can profitably use additional funds for labor and materials, that they communicate with the local loan agency of this Corporation serving the territory in which such concerns are located.

Each Loan Agency of the Corporation will, when requested, assist and advise with applicants in determining their eligibility and in the preparation of applications.

JESSE H. JONES,
Chairman, Reconstruction Finance Corporation.

Washington, D. C., Nov. 9, 1934.

A Little More History

Editor, METALS & ALLOYS:

In view of the increasing importance of oxygen determinations in steel, it will be of historical interest to publish a photograph of, in all probability, the first apparatus assembled in America.

Ericson in 1931

About 1903 the writer was commissioned by the late Chief Chemist of South Works, Illinois Steel Company, William Brady, to make oxygen determinations on steel. After a survey of the literature, the Ledebur method was decided on. A detailed description of this method had been published in *Stahl und Eisen.*

The assembled apparatus, as shown by the photograph, allowed heating the sample first in an atmosphere of nitrogen (left, rear of train) then in one of hydrogen (right, rear with purifying train) each gas in turn entering the combustion tube containing the sample in the foreground. The oxides of iron and manganese were reduced and the water formed absorbed in a weighed phosphorus pentoxide bulb. Oxides of silicon and aluminum would remain unaffected.

The Ledebur Apparatus in 1902

As I recall it now, most determinations ran from .005 to .030% oxygen and were on Bessemer and open hearth steels. Two determinations could be made in a day.

I trust this will supplement your recent series of articles, on work of the early steel chemists by Messrs. Spring and Gilmore.

ERIC JOHN ERICSON,
Chief Chemist,
Standard Forgings Co.

East Chicago, Ind.
November 4, 1934

Rapid Test of Thickness of Tin Coatings on Steel

The International Tin Research & Development Council has issued as Technical Publication, Series A, No. 12 a reprint of a paper by Dr. S. G. Clarke, published in "The Analyst," which describes a new rapid method of determining the thickness of a tin coating on steel. The procedure is simple; the tin is dissolved from a known area by a cold solution of hydrochloric acid and antimony chloride, and its amount is determined by the loss of weight of the specimen. The basis metal is unattacked, but a small correction has to be applied to allow for the layer of tin-iron alloy. In addition to brevity, the method has the advantage that the thickness of tin on a given portion of the surface can be determined by protecting the remainder with a coating of cellulose varnish. Copies of this paper may be obtained from the International Tin Research & Development Council, L. J. Tavenor, U. S. Representative, 149 Broadway, New York City.

New Cold Mill

Contracts have been awarded for erecting the Youngstown Sheet & Tube Company's new cold rolling mill at Campbell, to the Mesta Machine Co. of Pittsburgh, and the steel will be erected by the Fort Pitt Bridge Co.

The new cold rolling mill, with a capacity of from 200,000 to 250,000 tons a year, will absorb a part of the production of the new continuous strip mill now being erected by the company at Campbell, which will have an annual capacity of from 500,000 to 600,000 tons of hot rolled strip. The cold mill will finish strip into sheets for automobile and other purposes. A separate building, covering 216,000 square feet will house the cold rolling mill equipment. The latter will include one 3-stand tandem 4-high finishing unit, and two single stand 4-high mills along with continuous annealing, pickling, shearing, and straightening machinery. The cold mills will be capable of rolling down the unfinished hot strip to 26 gage thick and 84 inches wide.

CURRENT

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ORE CONCENTRATION (1)

- Crushing, Grinding & Plant Handling (1a)
- Gravity Concentration (1b)
- Flotation (1c)
- Magnetic Separation (1d)
- Amalgamation, Cyanidation & Leaching (1e)

ORE REDUCTION (2)

- Non-Ferrous (2a)
- Ferrous (2b)

MELTING, REFINING AND CASTING (3)

- Non-Ferrous (3a)
- Ferrous (3b)

WORKING (4)

- Rolling (4a)
- Forging & Extruding (4b)
- Cold Working, including Shearing, Punching, Drawing & Stamping (4c)
- Machining (4d)

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- Hardening, Quenching & Drawing (5b)
- Aging (5c)
- Malleableizing (5d)
- Carburizing (5e)
- Nitriding (5f)

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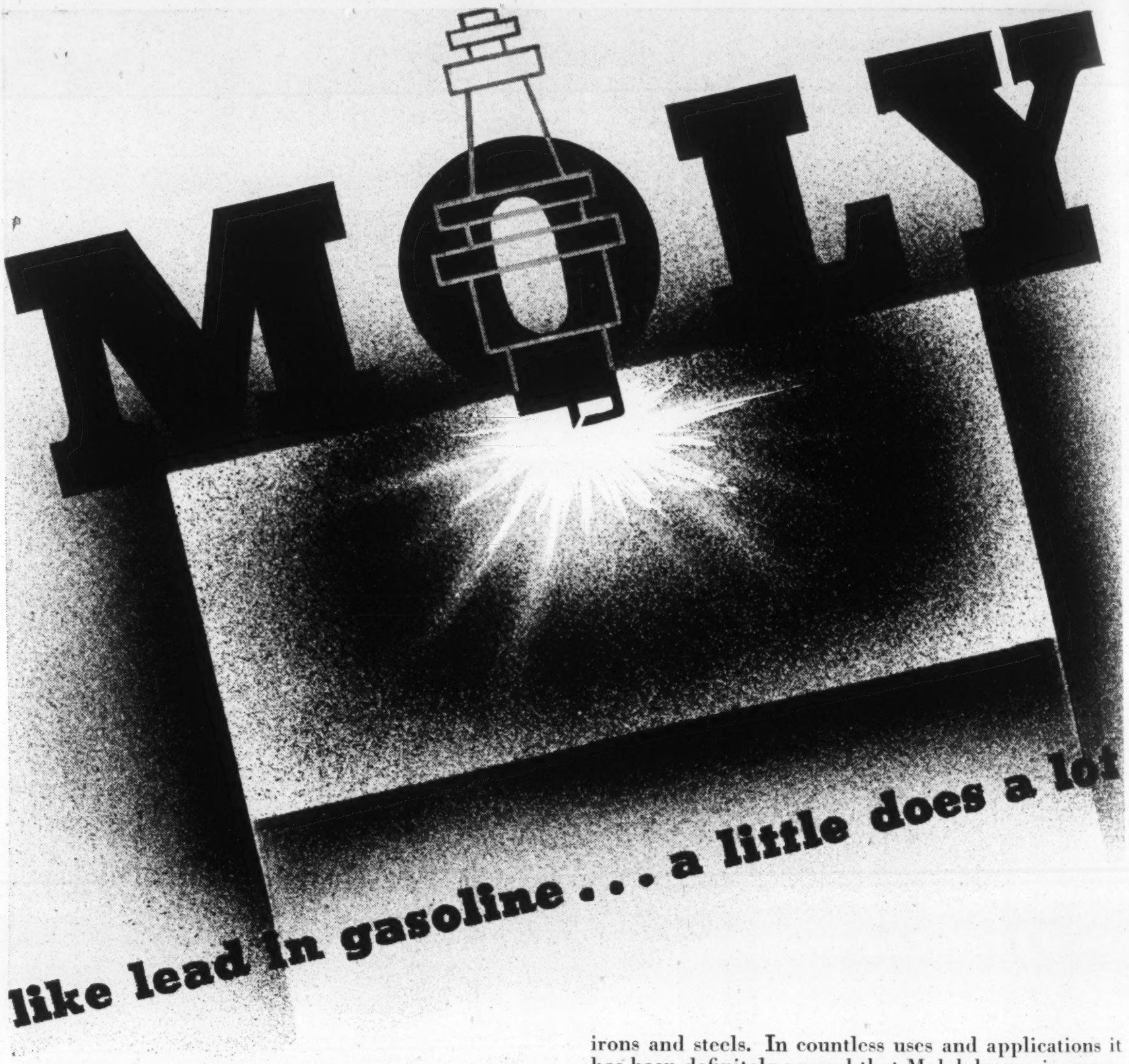
- Historical (15b)



WHAT is probably the most remarkable of "Moly's" many qualities toward improving iron and steel becomes strikingly apparent in its use in copper-bearing ingot iron. *Less than one-tenth of one per cent* is known to allow the addition of twice as much effective copper in ferrous metals designed to resist atmospheric corrosion and that encountered in mildly acid or oil-refinery liquors.

In fact, service data show copper-Molybdenum ingot iron considerably more resistant to atmospheric corrosion than copper-bearing steels. And one oil refinery claims that in contact with corrosive oils at elevated temperatures this material has outlasted plain carbon steel by *more than three times.*

The outstanding development of modern metallurgy is unquestionably the growth in use of Molybdenum irons and steels. In countless uses and applications it has been definitely proved that Molybdenum increases resistance to corrosion, fatigue, shock, creep, abrasion and temper embrittlement in plain or otherwise alloyed irons and steels. Making heat-treated steels easier to machine and weld—without loss of strength—is another of its characteristics. And its ultimate possibilities have not yet been approached.

"*The Moly Matrix*" is our new house organ, planned to help executives and engineers keep informed of Molybdenum's progress. A simple request puts you on our mailing list. A further request brings you either or both of these new books: "*Molybdenum in* 1934" and "*Molybdenum in Cast Iron*—1934 *Supplement.*" And our metallurgists and experimental laboratory in Detroit offer ready assistance toward solving any alloy problems you may have. Climax Molybdenum Company, 500 Fifth Avenue, New York.

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CLIMAX Mo-lyb-den-um

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

Mining and Milling Practices at Small Gold Mines. E. D. GARDNER & C. H. JOHNSON. *United States Bureau of Mines, Information Circular* No. 6800, July 1934, 31 pages. Three types of Au mills are common,—(1) amalgamation—gravity concentration, (2) flotation and (3) cyanidation. Typical flow sheets for each are described. The conditions governing the choice of methods are discussed. AHE (1)

Recovery of Gold from the Ore of the Beattie Gold Mine Limited, Duparquet Township, Abitibi County, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 71-96. The best method for recovery of Au from ore assaying Au 0.15—0.26 oz. and Ag 0.08—0.16 oz./ton was flotation, roasting the concentrate and cyanidation of the calcine. Extraction by this method was 82%. Direct cyanidation of the ore gave only about 60% recovery; cyanidation of unroasted concentrates extracted 65-70% of the Au. AHE (1)

The Recovery of Gold from the Arsenical Ore of the Cameron Island Mine, Shoal Lake, Lake of the Woods, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 60-63. The ore containing pyrite, arsenopyrite, pyrrhotite, native Au and chalcopyrite assays Au 0.65 oz./ton and As 3.55%. The flow sheet proposed is flotation of ore ground to 50%-200 mesh, roasting of the concentrate and cyanidation of the reground calcine. Extraction is about 80%. AHE (1)

The Recovery of Gold from Treadwell-Yukon Ore, Bussière Property, Louvicourt Township, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 45-50. An ore containing 2.31 oz. Au and 0.38 oz. Ag/ton and 0.55% Cu was studied. Cu attacks the cyanide resulting in excessive losses. Flotation removes the Cu and also most of the Au. Amalgamation of ore 70% —200 mesh recovers 91% of the Au. Another 8% is recovered in a Cu concentrate, of a grade suitable for shipment to a smelter. AHE (1)

Experimental Tests on a Sample of Gold Ore from Alexandria Gold Mines, Limited. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 50-53. Cyanidation of a quartz-pyrite ore containing 0.25 oz. Au/ton gave 70% recovery. Amalgamation made no recovery. Flotation and sale of the concentrate to a smelter are recommended. AHE (1)

Experimental Tests on Gold Ore from the Mackey Point Syndicate, Michipicoten Area, Ont. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 204-211. An ore assaying Au 0.39 oz./ton was amalgamated; recovery was about 90%, cyanidation of the tails increased recovery to 98%. Straight cyanidation recovered 97-99%. Blanket concentration recovered 92%, flotation of tailings 5% more. Amalgamation of blanket concentrate and cyanidation of flotation concentrate gave 95% recovery. AHE (1)

The Recovery of Gold in Ore from the De Santis Gold Mining Company, Limited, Timmins, Ont. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 20-21. An ore, containing Au 0.43 and Ag 0.07 oz./ton, was treated. At —150 mesh, 96% of the Au is recoverable by cyanidation while 98.8% is recovered at —200 mesh. Flotation recovered 96.9% of the Au in a rougher concentrate that can be cleaned to 2.40 oz. Au/ton. AHE (1)

Recovery of Gold, Silver, Lead and Zinc from Ore of the Yankee Girl Mine at Ymir, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* 736, 1934, pages 99-109. An ore containing Pb 2.42, Zn 4.50, Fe 9.37, S 10.51%, Au 0.50 oz. and Ag 2.59 oz./ton yielded only 70-75% of the Au to cyanidation. By flotation, 90% of the Au, Ag and Pb may be recovered in a bulk concentrate. The same net result was obtained by taking the Pb and Zn concentrates off separately. AHE (1)

Ore Concentration. Metallurgical Results and Flotation Reagents. T. H. MILLER & R. L. KIDD. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook*, 1932-33, pages 225-238. AHE (1)

Ore-Dressing Bibliography, 1931-32. T. H. MILLER & R. L. KIDD. *United States Bureau of Mines, Information Circular* No. 6784, June 1934, 89 pages. AHE (1)

Detailed Statistical Microscopic Analyses of the Ore and Mill Products of the Silver King Flotation Concentrator, Park City, Utah. R. E. HEAD, ARTHUR L. CRAWFORD, F. E. THACKWELL & GLEN BURGENER. *United States Bureau of Mines Report of Investigations* No. 3236, June 1934, 70 pages. The mill feed is galena 15.1 gray Cu 1.4, sphalerite 8.4, pyrite 15.5 and nonmetallic gangue 59.5% (about 45% quartz and 15% carbonates). Pb concentrate, Zn concentrate, general tailings and various specimens of average mill feed were sized and briquets prepared representing each mesh size from + 65 to —800 mesh. An immense amount of data on these are given including mineralogical and chemical composition of feed, Pb concentrate, Zn concentrate and tails; mineralogical distribution of Ag in each; distribution of sphalerite, gray Cu, pyrite and gangue in various size fractions of the Pb concentrate; distribution of galena, gray Cu, pyrite and gangue in Zn concentrate; distribution of foregoing in tailings; distribution of metals in various size fractions of various minerals in different mill products; free and locked mineral relationship in each size of the different mill products; etc. The data lead to detailed suggestions for improved grinding, for increasing Zn recovery, for improvement of Zn separation from the Pb concentrate and improvement of separation of Ag from Zn concentrates. AHE (1)

Crushing, Grinding & Plant Handling (1a)

Briquetting Fine Iron Ores for Open Hearth Furnace Use. B. S. ABRAMOV & D. A. BRAUN. *Domez*, No. 4, 1934, pages 21-32 (In Russian). Iron ore briquettes are not suitable for blast furnace use but are advantageous as open hearth furnace additions. Briquetting without a binder under pressure up to 3000 kg./cm.^{2} was not satisfactory. $Ca(OH)_2$ as binder required 20-30 day storage before hardening. Steaming with superheated steam under 5 to 8 atmospheres hardens $Ca(OH)_2$-containing briquettes sufficiently well within 5 to 6 hours. Conversion of $Ca(OH)_2$ into hard limestone by means of a stream of furnace gases required several days. Keeping these briquettes in an autoclave under 2 atmospheres of CO_2 for two hours and heating them for one hour in a stream of CO_2 heated to 110°-160°C. gave to them the required strength. With 4% of cement 10 to 12 days are required for hardening. (1a)

The Starting up of Tube Mills. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, May-June 1934, page 217. The relation of the frictional resistance in starting heavy mills and the actual starting power required is discussed. AHE (1a)

Screening-Vibrating Screen Practice. J. G. TURVEY. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, July-Aug. 1934, pages 247-250. The principles of vibrating screens, the various kinds of vibrating units, binding devices, tension and cloth length for screens are discussed. AHE (1a)

1

Grinding Tests for Easy Interpretation of Results. W. H. COGHILL & F. D. DEVANEY. *Progress Reports—Metallurgical Division. 5. Ore-Dressing Studies. United States Bureau of Mines, Report of Investigations* No. 3239, June 1934, pages 3-8. In drop weight tests of grindability characteristics, surface tons/hp.-hr. (200 mesh) were chert 23.6, quartz 53.2, Ill. coal 123.0, dolomite 67.2, pyrite 69.5 and sphalerite 71.8; tons/hp.-hr. were chert 0.200, quartz 0.415, Ill. coal 0.568, dolomite 0.605, pyrite 1.045, and sphalerite 1.12. Results of grinding dolomite and flint in a ball mill and rod mill, between rolls and by drop weight are compared tabularly and show that the relative effectiveness varies with different ores and depending on whether interest is in tons/hp.-hr. or surface tons/hp.-hr. Results of grinding in a rod mill with grinding media of sp. gr. 2.89, 4.7, 5.00, 6.66, 7.3 and 7.7 at critical speeds of 40, 50, 60, and 70% show that the rods (sp. gr. 7.7) were about 30% more efficient than the stuffed pipes (sp. gr. 2.89-7.3), possibly due to the greater hardness of the rods. Feed of 0.48, 0.90 or 2.04 tons of dolomite/hr. to rolls gave 0.60 tons/hp.-hr.; feed of 0.12, 0.36, or 0.54 tons of flint/hr. gave 0.20 tons/hp.-hr. Capacity and efficiency were greatest at highest rate of feed. AHE (1a)

2

Material Handling Equipment. (4) Belt Conveyors. W. G. PICTON. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, July-Aug. 1934, pages 253-256, 258, 260, 262. Data are given on maximum speed, idler spacing, belt stress, pulley diameter, capacity for materials of varying density, size of largest lump, power requirements (for varying belt speeds of 50-600 ft./min.), conveyer angle, etc., for various belt widths (12-48 in.) AHE (1a)

Gravity Concentration (1b)

3

The Concentration of Chromite Ore from Obonga Lake, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 6-9. Flotation of ore containing 4.44% Cr_2O_3 gave no concentration, because talc floated more readily than the chromite. Table tests at various sizes down to -200 mesh gave a maximum of 38% Cr_2O_3 in the concentrate. AHE (1b)

The Concentration of Chromite from Lake Shebandowan, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 9-13. An ore containing 16.85% Cr_2O_3 was concentrated by tabling under various conditions. The best results were a concentrate assaying 30% Cr_2O_3 at 65-70% recovery. This is about the best possible due to the high Fe and Al ratio in the chromite. AHE (1b)

4

The W. S. C. Placer Mill. GUY E. INGERSOLL. *State College of Washington, Mines Information Bureau, Information Circular* No. 2, July 1933, 5 pages. Au is caught on corrugated rubber and sponge rubber sheets on a vibrating table. The concentrate is amalgamated in a barrel. AHE (1b)

Expansion of Centralized Milling and Tailing Retreatment Operations in the Tri-State Zinc-Lead Mining District. FRANK J. CUDDEBACK & WM. F. NETZEBAND. *Mining Congress Journal*, Vol. 20, Sept. 1934, pages 30-36, 53. Describes the Bird Dog Mill and the Eagle-Picher Central Mill, both of which have been put into operation since 1930. Flow-sheets of both mills given. Use of better equipment and continuous operation have resulted in higher recoveries, lower investment and operating cost, and a better control of concentrate, compared with the old system of milling. Over 20 mills in the district are now operating on old tailings, which are first treated in Cooley jigs, followed by tables, ball mills, and flotation cells. About 20% of the concentrates produced in the district are made from old tailing dumps. BHS (1b)

5

Flotation (1c)

6

Tests on Gold-Silver-Lead-Zinc Ore from the Alice Lake Group of Mineral Claims Near Quatsino Sound, Vancouver Island, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 53-58. A galena-sphalerite-pyrite ore in a limestone gangue assayed Au 0.335 oz. and Ag 3.23 oz./ton, Cu 0.14, Pb 5.76, and Zn 6.38%. The Ag is associated with the galena and the Au with the pyrite. Fair grades of Pb and Zn concentrates can be obtained by selective flotation (21-31% Pb at 91-94% recovery; 48-50% Zn, 69-75% recovery). The Pb concentrate contains much pyrite which is impossible to depress; up to 55% of the Au is recovered here and 30-35% more in a subsequent pyrite concentrate. A bulk flotation concentrate of galena and pyrite contained 68% of the Au, less than the 2 selective concentrates. Au can not be cyanided. The concentrates must be smelted. AHE (1c)

7

Theory of Mineral Flotation. Actual State of Our Knowledge of Chemical Collectors (La Théorie du Flottage des Minerais. L'État actuel de nos Connaissances sur les reactifs Collecteurs). M. REY. *Revue universelle des Mines*, Series 8, Vol. 10, Aug. 15, 1934, pages 433-439; Sept. 1, 1934, pages 466-471. The various theories of the flotation process are reviewed with particular reference to the constitution and manner of action of chemical collectors. Under normal flotation conditions, minerals are hydrophilic and the function of the reactive collectors is to form an organic, hydrophobic film on their surface; the film should have the thickness of a molecule, and the chemical collectors which are principally an active or polar group, orientate themselves in the film with the hydrocarbon group towards the outside. This explanation agrees better with actual facts than the chemical theory according to which the stability of the film depends on the chemical reaction of the collector with the mineral. More recent studies of adsorption, however, (Langmuir) have approached both these theories. This is illustrated by the flotation of galena with xanthate; galena is represented by PbS and oxidized galena by [PbS] $Pb^{++}+SO_4^{--}$; the SO_4^{--}-ions are kept in the immediate vicinity of the macro-ion [PbS] Pb^{++} by electrical attraction but are partly free in the solution. The reaction with a xanthate NaR which dissociates into Na^+ ions and R^- ions, forms a macro-molecule [PbS] PbR_2 composed of galena covered with a film of insoluble lead xanthate. The connection of this problem with the recent investigations into structure of atoms, molecules and crystals is pointed out. 44 references. Ha (1c)

8

Concentration of a Cobalt Ore from Werner Lake, Red Lake Mining Division, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 63-66. By selective flotation of an ore containing 10.72% Co and 0.30% Cu, about 60% of the Cu can be removed as a concentrate assaying 5-6% Cu and about 10% Co, a loss of 3% of the Co. A Co concentrate containing 26% Co at 90% recovery and less than 0.3% Cu is produced. AHE (1c)

9

Flotation Concentration of Siscoe Gold Ore. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 40-45. After removing coarse Au and part of the sulphides by trap and blankets, Au in the residue can be reduced to 10 cents a ton by flotation. Recoveries of 98% can be secured by omitting the blankets before flotation. The concentrate contains 33 oz. Au/ton and tailings 20 cents/ton. The Au is readily soluble in cyanide. AHE (1c)

10

Flotation of Siscoe Gold Mines Classifier Overflow. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 39-40.—A classifier overflow containing 0.14 oz. Au and 0.10 oz. Ag/ton was floated to give a concentrate assaying 14.16 oz. Au and 90% recovery. AHE (1c)

The Concentration of the Disseminated Copper-Nickel Ore of the Falconbridge Nickel Mines, Limited, Falconbridge, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 171-185.—Highest recoveries were obtained in a soda ash circuit; good recoveries were obtained using CaO and cement as alkali reagents. A heavy oil mixture showed advantage over chemical collection. Xanthates were necessary for low tailings. Mill runs improved on laboratory results; Cu recoveries were 99% and Ni 98%. Reagent consumption was soda ash 1.5-2.0, oil 0.20-0.30, P. A. xanthate 0.15-0.25 and Yarmor pine oil 0.05-0.15 lb./ton. AHE (1c)

Tests on Gold-Silver-Lead-Zinc Ore from Bey Mines, Limited, Northbrook, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pp. 116-123. The ore, assaying Cu 0.58, Pb 6.65, Zn 6.60%, Au 0.35 oz. and Ag 24.96 oz./ton, contained too much Cu to treat by cyanidation in its raw state. Best Au recovery can be obtained by floating off a Cu-Pb concentrate and cyaniding the tailing. Such a concentrate will contain 50-75% of the Au, 80-85% of the Ag and 90% or more of Cu and Pb. By cyanidation, 93% of the Au in the tailing is recovered, to make over-all recovery 96-98%. AHE (1c)

The Concentration of Copper and Gold in Greene-Stabell Ore, Dubuisson Township, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 123-130.—Fine grinding is essential for highest recoveries. Flotation of ore 85-90% -200 mesh recovered 94% of the Cu and 82% of the Au. An alkaline circuit yields higher recoveries than a neutral one. Cleaning the rougher concentrate tends to drop out the Au. A rougher concentrate carrying 7% Cu and 6-8 oz. Au/ton is the average to expect. AHE (1c)

Contribution to the Principles of Flotation (Beiträge zu den Grundlagen der Flotation). PHILIPP SIEDLER. *Kolloid-Zeitschrift*, Vol. 68, July 1934, pages 89-102. A theoretical and experimental discussion of the question whether a laminar or linear arrangement of the collecting molecules takes place in the flotation process and which part the contact angle of mineral surfaces plays in the process. The observations of Wark and Cox that no measureable contact angles occur on pure cleavage faces of galena, sphalerite, copper pyrites, calcite and barite were confirmed. The adsorption velocity of xanthates decreases with the hydrocarbon chain, the metallic yield of the process increases with this chain in the same sense as the marginal angle. A new diagram for the connection of crystal and air bubble is developed. 20 references. Ha (1c)

Pilot Mill Flotation Work at the Property of the Bagdad Copper Corporation, Hillside, Arizona. G. GAMLEN THOMAS. *Bulletin of the Institution of Mining & Metallurgy*, No. 358, July 1934, 43 pages; No. 360, Sept. 1934, page 17 (discussion). The most important minerals are pyrite and chalcopyrite in the protore, chalcocite in the enriched ore, and malachite in the carbonate ore. Results of 51 pilot plant flotation tests and 8 mill tests are presented tabularly. In pilot plant and mill tests, respectively, Cu in heads was 0.91-2.73 (av. 1.317), 0.57-1.33; tails 0.01-0.48, 0.05-0.11; concentrates 23.34-51.70 (av. 37.77), 20.60-40.90; and recovery 69.3-98+(av. 87.5), 87.9-94.4%. Pine oil and Aerofloat No. 25 are the only reagents needed; these were sprayed onto the dry ore. No pulp modifier for alkalinity control was used. AHE (1c)

A History of the Introduction of the MacArthur-Forrest Cyanide Process to the Witwatersrand Gold Fields. JAS GRAY & J. A. MCLACHLAN. *Journal Chemical, Metallurgical & Mining Society of South Africa*, Vol. 33, Nov. 1933, pages 202-203; May 1934, page 382, discussion. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 466. AHE (1c)

Physical Chemistry of Wetting Phenomena and Flotation Processes (Zur Physikochemie der Benetzungserscheinungen und Flotationsprozesse). M. LIPITZ & M. RIMSKAJA. *Kolloid-Zeitschrift* Vol. 68, July 1934, pages 82-89. The effects of flotation reagents (activators, depressants, etc.) used in flotation processes were investigated according to the method developed by Rehbinder, and the changes in the molecular nature of mineral surfaces caused by them studied on a series of typical minerals, as sphalerite, pyrite, smithsonite, etc. The surface reactions were determined by measuring the hysteresis wetting isotherms, from which optimum concentration and most favorable amount of reagents could be developed. 15 references. Ha (1c)

Theory of Flotation (Zur Theorie der Flotation). WO. OSTWALD. *Kolloid-Zeitschrift*, Vol. 68, July 1934, pages 103-109. Discussing recent views on the principles of flotation it is maintained that average wettability rather than non-wettability of the ore particles is the condition for flotation; a contact angle of 90° instead of 180° gives the best conditions. These premises are necessary for the application of the linear theory. 21 references. Ha (1c)

Three-Product Flotation at Britannia. Separation of Copper-Zinc-Iron from Low-Grade Ore. H. A. PEARSE. *Transactions of the Canadian Institute of Mining and Metallurgy*, 1934 (*in Canadian Mining and Metallurgical Bulletin* No. 267, July) pages 341-350. The ore contains chalcopyrite, pyrite, sphalerite, Au and Ag A bulk concentrate is produced by flotation, reground and refloated to give a Cu concentrate, a Cu-Zn middling (retreated), a Zn concentrate and a pyrite product. Reagents added, lb./ton of original feed, are: at ball mill, —hydrated lime 0.65; at rougher—$CuSO_4$ 0.15, ethyl xanthate 0.06, pine oil 0.08; at thickeners,—hydrated lime 0.10; at regrinding mill,—hydrated lime 0.10, NaCN 0.04, $ZnSO_4$ 0.23; Cu flotation,—butyl xanthate 0.005, pine oil 0.01; Zn flotation, hydrated lime 0.10, $CuSO_4$ 0.02, butyl xanthate 0.007; pyrite flotation,—$CuSO_4$ 0.03, ethyl xanthate 0.02. A pH of 9.0 is maintained. Mill feed assays Cu 0.60, Zn 1.35, Pb 0.12, Fe 5.0, S. 5.0% and Au 0.04 oz./ton. Cu concentrate assays Cu 23.40, Zn 7.85, Pb 4.3, Fe 24.7, S 33.8, insoluble 3.6% and Au 1.24 oz. Zn concentrate assays Cu 1.40, Zn 55.7, Pb 0.65, Fe 6.7, S 33.6, insoluble 1.3%, and Au 0.09 oz. Pyrite concentrate assays Cu 0.44, Zn 2.0, Pb 0.03, Fe 43.1, S 50.1, insoluble 3.7% and Au 0.14, oz. Tailings assay Cu 0.09, Zn 0.30, Pb 0.03, Fe 2.8, S 1.9% and Au 0.013 oz. Recovery of Cu is approximately 81%, Au 60% in the Cu concentrate, and Zn 65%. AHE (1c)

Flotation and Depression of Nonsulphides: Calcite, Silica and Silicates, Fluorspar, Barite, Apatite, and Tungsten Minerals. J. BRUCE CLEMMER & R. G. O'MEARA. *Progress Reports—Metallurgical Division. 5. Ore-Dressing Studies. United States Bureau of Mines, Report of Investigations* No. 3239, June 1934, pages 9-26. Fluorspar and barite can be separated from calcite by several reagent combinations. W ores can be treated successfully by soap flotation to yield high-grade concenrates low in the most objectionable impurities. Sulphides may be removed by flotation with customary reagents without affecting subsequent soap flotation. W ores free of calcite and apatite require only an alkaline depressant for the siliceous gangue. W ores free of calcite but containing apatite can be treated with (1) an acid reagent in both roughing and cleaning or (2) an alkaline reagent in roughing and an acid reagent in cleaning. W ores containing calcite or other carbonates are treated successfully by a combination of metal salt-silicate in the rougher and an alkaline or acid reagent in the cleaner. Fatty acids and their derived soaps are not good selective flotation reagents; depressants for gangue must be used. Soluble silicates are the principal siliceous gangue-depressing reagents used in soap flotation. When soluble salts are present, soda ash or caustic often are used alone or together with silicate. Acidified dichromate and the inorganic or short chain organic acids usually give slightly higher recovery of better-grade concentrates than is possible with soluble silicates. Carbonate gangue minerals are more difficult to depress than siliceous gangue. Calcite can be depressed by a silicate-acid combination. A metal salt-silicate combination also is effective. $CuSO_4$ usually is used, but other metal salts give equally good results. In cleaning sulphide concentrates, dihydroxyorganic acids, such as tartaric, are powerful depressants for nonsulphides. AHE (1c)

Concentration of Surf Point, Porcher Island, Gold Ore. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pp. 165-170. Ore containing Au 1.135-1.64 oz. and Ag 0.51-0.86 oz./ton was not amenable to amalgamation or cyanidation. Flotation yields 97.6% of the Au. AHE (1c)

Magnetic Separation (1d)

Magnetic Concentration of Iron Sands from Black Bay, Port Arthur, Ont. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 97-98.—Magnetic concentration of a sand containing Fe 33.62, TiO_2 9.76 and SiO_2 16.30% gave a concentrate (47.8%) analyzing Fe 51.3, TiO_2 17.4 and SiO_2 4.7%. Grinding this concentrate to 100 mesh and reconcentrating gave a concentrate (85.4%) analyzing Fe 55.8, TiO_2 16.8, V_2O_5 1.06 and SiO_2 1.25%. AHE (1d)

Concentration of Scheelite Ore from Indian Path Mines, Lunenburg, Nova Scotia. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch, Report* No. 736, 1934, pages 25-29. A scheelite ore containing 3.95% WO_3 associated with arsenopyrite, pyrite, pyrrhotite and quartz was concentrated to 65-70% WO_3 with more than 80% recovery by a magnetic roast followed by magnetic separation in a high-intensity machine. Table concentration gave a product above the limit of 0.5% As. A flow sheet is proposed. AHE (1d)

Magnetic Separation of Vanadium-bearing Titaniferous Magnetite from Mine Centre, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 213-218. Two suggested flow sheets are presented. Data are given on several tests. AHE (1d)

Alternating-Current Magnetic Separation of Iron Ores. C. W. DAVIS. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 35-37. When minerals sufficiently fine to assure mechanical freedom are magnetized and passed through a magnetic field produced by an alternating current of suitable characteristics the particles with higher remanence, provided that they have sufficient coercive force to prevent demagnetization, will jump about and may be separated in various ways from other particles with lower remanence or less coercive force. Lodestone jumps actively in an A. C. field of moderate intensity. Other varieties of magnetite are strongly susceptible but have a much lower coercive force, so that if A.C. separation is desired, a much weaker field strength must be used on the magnetized material to prevent demagnetization. The activity of such particles is rather weak but may be augmented by regulated heat treatment which increases coercive force sufficiently to permit easy A. C. separation. The effect of heat treatment is especially marked if the mineral contains small amounts of Ti. Drastic heating of magnetite reduced its activity in A. C. fields. Partially reduced hematite may be magnetized and then resembles lodestone. Hematite treated with a little NaOH and heated in a closed crucible may be separated by A. C. Heating impure hematite in closed containers changes its magnetic properties. Control of the magnetic properties of hydrated oxides of Fe is rather complicated and has not been worked out. A light roast of Fe sulphides produces magnetic sulphides with high remanence and coercive force. AHE (1d)

Amalgamation, Cyanidation & Leaching (1e)

Dissolution of Various Copper Minerals. STEPHEN L. BROWN & J. D. SULLIVAN. *Progress Reports—Metallurgical Division. 3. Studies in the Metallurgy of Copper. United States Bureau of Mines, Report of Investigations* No. 3228, May 1934, pages 37-51. Data are given on the dissolution of various sizes of the following minerals in different times from 1/2 hr. to 146 days in H_2SO_4, $Fe_2(SO_4)_3$ and various mixtures of them: chrysocolla, dioptase, enargite, tennantite, tetrahedrite, chalcopyrite (also in $FeCl_3$ and in Cl_2 water) and metallic Cu. The oxidized minerals dissolve most readily and complex sulfides the most slowly. The order of increasing difficulty is chalcocite, bornite, covellite, chalcopyrite and enargite. When chalcocite is leached with $Fe_2(SO_4)_3$, 1/2 the Cu dissolves rapidly leaving a residue approximating CuS that dissolves much more slowly than the first 1/2, but more rapidly than natural covellite. With bornite, Cu is attacked preferentially to Fe. With chalcopyrite the CuFeS ratio is constant during dissolution. AHE (1e)

The Recovery of Gold from the Ore of the Ashley Property, Matachewan Area, Ontario. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 3-6. Straight cyanidation recovered 97.8% of the Au from -150 mesh ore. Results on amalgamation and cyanidation and on flotation and cyanidation are given. AHE (1e)

Recovery of Gold from Black Sand Concentrate from North Bend, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 96-97. The Au in a black sand concentrate containing Au 1.85 oz./ton can be recovered by amalgamation. AHE (1e)

Cyanidation of Flotation Concentrates from Bralorne Mines, Ltd., Bridge River District, B. C. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 69-71. Cyanidation of a concentrate containing 9.56 oz. Au and 3.32 oz. Ag/ton resulted in 90% extraction of Au. The solution fouls. AHE (1e)

The Recovery of Gold from Ore of the Cariboo Gold Quartz Mining Company, Limited, Barkerville, British Columbia. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 66-69. Pyrite in quartz assaying 1.04 and 2.925 oz. Au/ton was treated. Amalgamation of -48 mesh ore recovered 80% of the Au; cyanidation of the $4 tailing recovered all but 50 cents. By finer grinding, 97.1% of the Au can be so recovered. Straight cyanidation of -150 mesh ore gave 98.6% recovery. AHE (1e)

Experimental Tests on Gold Ore from Herb Lake, Manitoba. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 59-60. The ore is readily amenable to amalgamation; 96.7% of the Au was recovered at 50% -200 mesh. Two flow sheets are recommended. AHE (1e)

The Recovery of Gold from the Ore of the St. Germaine-Gale Property, Dubuisson Area, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 29-32. Amalgamation, flotation and cyanidation tests at various degrees of grinding showed that approximately 82% of the Au can be amalgamated at -48 mesh. Flotation of the residue recovers an additional 12%. Cyanidation of the ore recovers 95% of the Au. AHE (1e)

Experimental Tests on Samples of Concentrates from Granada Gold Mines, Ltd., Rouyn, Quebec. C. S. PARSONS, A. K. ANDERSON, J. D. JOHNSTON & W. S. JENKINS. *Canadian Department of Mines, Mines Branch Report* No. 736, 1934, pages 22-25. A primary blanket concentrate containing Au 5.32 oz. and Ag 2.68 oz./ton, Fe 18.36, As 10.50, S 12.75, Cu 0.01, Pb 0.20, and Zn 0.15% and a secondary concentrate assaying Au 2.64 oz. and Ag 0.90 oz./ton, Fe 15.80, As 7.90, S 10.25, Cu tr., Pb 0.05 and Zn 0.10% were cyanided with recoveries of 98-99%. Cyanide and lime consumption were not excessive. Flotation was unsuccessful. AHE (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Contributions to the Data on Theoretical Metallurgy. II. High-temperature Specific-heat Equations for Inorganic Substances. K. K. KELLEY. *United States Bureau of Mines, Bulletin* 371, 1934, 78 pages. Available high-temperature thermal data on elements and their inorganic compounds are reviewed and representative specific heat equations valid at high temperatures are given. Heat contents above 273.1° are given tabularly for 135 elements and compounds. The a, b, and c constants for specific heat equations of the form $C_p = a + bT - cT^{-2}$ the estimated average error for the equation, the temperature range over which applicable and heats of transition, fusion and vaporization for 326 substances are tabulated. Estimated specific heat equations are given for 253 substances for which published data are not complete enough to warrant inclusion with the foregoing. Includes 241 references. AHE (2)

Non-Ferrous (2a)

A Study of Reduced Ferberite as a Substitute for Ferrotungsten. V. H. GOTTSCHALK & DONALD J. DOAN. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Reports of Investigations* No. 3229, May 1934, pages 65-70. Ferberite was 98.5-99% reduced by H at 900°-1150°. The product obtained at 900-950° consisted essentially of a mixture of Fe and W. Above 1020° the product was amorphous or cryptocrystalline; annealed at 980° for 48 hrs., it developed the structure of Fe_3W_2 and metallic W. CO and H from natural gas were equally good reducing agents but the reduced product contained 1.3% C. Two heats of steel, identical in all additions except that (1) contained regular ferrotungsten and (2) the gas-reduced ferberite, analyzed, resp.: C 0.86, 0.74; Mn 0.36, 0.32; Si 0.35, 0.24; W 19.06, 19.4; Cr 4.37, 4.31; V 1.06, 1.04%. AHE (2a)

Contribution to the Problem of the Zero-Point Entropy of β-Graphite (Beitrag zur Frage nach der Nullpunktsentropie von β-Graphit). L. TEREBESI. *Helvetia Chimica Acta,* Vol. 17, July 2, 1934, pages 819-837. A comparison of the evaluated free energies and equilibrium constants of 5 reactions of β-graphite with the experimentally determined values does not indicate the existence of a zero-point entropy of β-graphite. This conclusion is particularly evident in the case of the thermal reduction of Al_2O_3 by β-graphite $[Al_2O_3]_{\alpha} + 3\,[C]_{\beta}$ graphite $\rightleftarrows 2Al + 3\,(CO)$.

Free energy and pressure data on this reaction are given under consideration of the Al and carbide tension. EF (2a)

Electrometallurgy of Aluminum (Zur Elektrometallurgie des Aluminiums). P. DROSSBACH. *Zeitschrift für Elektrochemie* Vol. 40, Aug. 1934, pages 605-608. The reactions in melts of cryolite—Al_2O_3 were investigated. The primary reaction in electrolysis of NaF seems to be $2NaF = 2Na + F$, and then $6Na + Al_2O_3 = 3Na_2O + 2Al$, or $6F_2 + 2Al_2O_3 = 4AlF_3 + 3O_2$ follow under depolarization. At very low current density the second reaction goes on quantitatively with 2.1 volt e.m.f. With increasing current density more F is developed and the depolarization voltage increases correspondingly under proper conditions; with prevention of diffusion of Al_2C_3 in the electrodes, this voltage can increase to 4.13. The thermodynamic calculations are carried out for different conditions. 11 references. Ha (2a)

Possibilities for the Production of Aluminum and Magnesium from Washington Ores. CARL F. FLOE. *State College of Washington, School of Mines and Geology, Metallurgical Research Bureau, Information Circular* No. 7, June 30, 1934, 5 pages. Production of Al from clays is feasible and probably can be done at a cost that will compare favorably with the present cost of producing it by the Bayer process from bauxite. Mg can be recovered from magnesites and dolomites at a cost that should compare with the present cost of extracting it from salt brines. Production of Al and Mg uses large amounts of electrical energy. AHE (2a)

Investigation of the Commercial Production of Calcium Silicon Alloys (Untersuchungen über die technische Herstellung von Calcium-Siliciumlegierungen). ROBERT WEINER. *Zeitschrift für Elektrochemie,* Vol. 40, Sept. 1934, pages 624-629. Alloys of Ca and Si are used in the steel industry for deoxidation especially for rust-resistant steels, because no C is introduced and the resulting Ca silicate slag is easily fluxed and removed from the steel bath, giving less possibility for formation of inclusions than with Al deoxidation. Tests were made in a small a.c. furnace (20-25 KVA) in which current and voltage were regulated for best conditions. Ca-Si alloy was made by melting CaC_2, quartz and coke; it contained 25-35% Ca. CaC_2 with excess C gave better results than with excess CaO. Direct production of Ca-Si alloy from lime, coke and quartz was possible but a large amount of slag was produced and the energy efficiency very low. WB (2a)

Risdon Zinc Works. Successful Treatment of Complex Ores. *Journal Institute of Engineers of Australia,* Vol. 6, Apr. 1934, page 147. Describes the operation of the Electrolytic Zinc Company of Australasia at Risdon, Tasmania. Complex ores are treated successfully yielding 150 tons/day of electrolytic Zn over 99.99% pure, 169 tons Cd/year, 79 tons Cu/year, 2,223 tons Pb/year and 221,000 oz. Ag/year. WH (2a)

Principles and Practice of Metallurgy at Falconbridge. A. GRONNINGSATER, J. R. GILL & R. C. MOTT. *Transactions, Canadian Institute of Mining & Metallurgy,* 1934 (*in Canadian Mining & Metallurgical Bulletin* No. 264, Apr.) pages 219-250. Fines go to sintering plant; coarse fines are low grade and used for converter flux. Magnetic sorting and hand picking divides lump into blast-furnace ore and concentrating ore. Bulk flotation of concentrating ore, aiming for low tailings, gives a concentrate which, when added to the direct smelting ore, forms a self-fluxing mixture with the slag on the basic side. Fines, concentrate and flue dust are sintered. A blast furnace is used for smelting. What converter slag is needed as flux is returned to the blast furnace. The flow sheet is described in detail. It results in lower metal losses than other possible methods. Capital costs are low; only a small flotation plant is needed; the small sintering plant, blast furnace and converter plant are cheaper than a roasting, reverberatory furnace and converter plant. AHE (2a)

Reducibility of Oxides of Alkali Earth Metals, including Beryllium (Ueber die Reduzierbarkeit der Oxyde der Erdalkalimetalle, einschliesslich des Berylliums). W. KROLL. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 219, Aug. 28, 1934, pages 301-304. The reducibility of an alkali metal and of Be can not be judged solely by its heat of formation; pressure and temperature must be taken into account. The reduction of Be by Ca is possible only with the addition of Al or other means by which the vapor pressure of the alkali metal is reduced. 9 references. Ha (2a)

Chemical Preparation of Cerium and Its Alloys (Préparation chimique du cérium et de ses alliages). A. KARL. *Bulletins de la société chimique de France,* Vol. 5, June 1934, pages 871-877. After failing to secure Ce in the electric furnace by reaction between CeO_2 and SiC, Ce of 97.05% purity and some of its alloys were prepared by reducing $CeCl_3$ with commercial Ca. The preparation of ferro-cerium offers no difficulties. The required quantity of Fe can be added before or after the reaction with Ca. A typical analysis shows 63.4% Ce, 35.85% Fe, 0.99% Cu, 0.33% Ca and 0.16% Mg. The method and equipment recommended for preparing Ce and its alloys as well as the various methods of making $CeCl_3$ are discussed at length. EF (2a)

Ferrous (2b)

1 **Nitrogen Content of Sponge Iron and of Metal Obtained by Melting Sponge Iron.** EDWARD P. BARRETT & CARL E. WOOD. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations,* No. 3229, May 1934, pages 53-60. Sponge Fe produced by heating mixtures of Fe ore and various solid fuels contained 0.01-0.06% N. Purest commercial Fe contains less than 0.005% N. Pure molten Fe has been reported to have absorbed 0.03-0.07% N. N in 4 Fe ores was 0.0018-0.0054%. Average N content of sponge Fe reduced with bosh gas was 0.01%; with CO, 0.005%; with H_2, 0.003%. Eight tests showed same N in sponge Fe prepared with H as in ore from which made. Samples of sponge Fe containing 0.003, 0.005, and 0.007% N were melted in Al-lined crucibles in a high-frequency induction furnace in an atmosphere of bosh gas. The resulting metals contained about 0.01% N. About 95% of the N was removed from sponge Fe containing 0.064% N by melting in H_2 in a high-frequency induction furnace. AHE (2b)

2 **Size Preparation of Iron Ores.** T. L. JOSEPH. *Progress Reports—Metallurgical Division. 6. United States Bureau of Mines, Report of Investigations* No. 3240, June 1934, pages 3-12. Reduction studies indicate that physical properties of sinter are more important than chemical in controlling rates of reduction. A method for determining Fe silicate in sinter is described. Ferrous silicate is slowly reduced and forms protecting coatings on magnetite. If SiO_2 is more than 10%, significant amounts of Fe will exist as silicate, and in all probability will reach the hearth unreduced. AHE (2b)

3 **Affinity of Metals for Oxygen. II. Equilibrium between Iron and Water Vapor (Die Affinität von Metallen zu Sauerstoff. II. Ueber das Gleichgewicht zwischen Eisen und Wasserdampf).** E. V. BRITZKE, A. F. KAPUSTINSKY & T. I SCHASCHKINA. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 219, Aug. 28, 1934, pages 287-295. The importance of reactions of Fe with H in metallurgical processes and methods for determining the equilibrium are discussed. A new method applicable up to 1225° C. was developed. A semi-empirical formula for the partial pressures of H and H_2O (vapor) was derived which agrees well with experimental data between 850° and 1200° C. 13 references. HA (2b)

4 **Reducibility of Kertch Ores and Their Sinters Produced in a Rotary Furnace and on the Dwight and Lloyd Machine.** A. N. POKHVISTNEV & M. S. GONCHAREVSKI. *Domez,* No. 7, 1934, pages 5-13. (In Russian). Kertch ores (16.32% SiO_2, 5.74% Al_2O_3, 59.49% Fe_2O_3, 0.95% FeO, 2.56% CaO, 0.68% MgO, 1.88% P_2O_5, 0.168% As_2O_3, 11.7 V. M.) lose their volatile matter at comparatively low temperatures. Heating for 30 minutes at any temperature between 600° and 1200° C. gave practically the same loss of weight. Reduction was conducted in the laboratory with dry, electrolytic H_2 and measured by the loss of weight and amount of H_2O absorbed. Of two samples calcined at 800° and 1100° C., the one heated to a lower temperature is more reducible at the beginning but after 20 minutes heating the ore calcined at 1100° C. could be reduced more easily. Reduction in the range 700°-1100° C. of ores calcined at 1100° C. showed approximately the same reducibility at all these temperatures after the first 25 minutes. (2b)

5 **Preparation of Ferro-chrome in the Electric Furnace (Sur la préparation du ferro-chrome au four électrique).** B. BOGITCH. *Comptes Rendus,* Vol. 197, Dec. 4. 1933, pages 1417-1419. See *Metals & Alloys* Vol. 5, Aug. 1934, page MA 383, OWE (2b)

Studies in Direct Production of Iron and Steel from Ore. Introduction. R. S. DEAN. *Progress Reports—Metallurgical Division. 4. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 3-5. Processes for direct production of Fe or steel are of 4 classes: (1) Solid ore → solid Fe + solid impurities, (2) solid ore → solid Fe + liquid impurities, (3) molten ore → solid Fe + liquid impurities, (4) molten ore → molten Fe + liquid impurities. Progress in each class is discussed briefly and illustrated with typical patents. AHE (2b)

6 **Reduction of Iron Ore by Natural Gas.** C. G. MAIER & S. B. THOMAS. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 39-47. Rate of reduction of Fe oxide by CH_4 was so slow as to be prohibitive below the sintering point of the reduced Fe (50 hours). Simultaneous introduction of air heated to 1000° nearly supplied the necessary thermal requirements, but at the temperatures required the sponge Fe was sticky and mechanical difficulties were encountered. In the first section of the kiln, H_2 and CO were formed. Isolation of this initial stage in a separate unit under accurate control increased H_2 and CO yields. Typical gas composition was N_2 42.7, CH_4 0.4, CO_2 0.3, CO 19.5, H_2 36.4 and H_2O 0.7%. Use of this reformed gas for reduction lowered kiln temperatures and time of treatment required (to less than 2 hours). Operation of a kiln 7 inches in diameter and 6 ft. long reduced 100-250 lbs. Fe/day depending on the size of the feed and the quantity of gas used. With a production of 125 lbs./day, over 99% of the Fe was reduced, and gas utilization was nearly complete for H_2 and nearly 75% for CO. Total gas consumption including preheating the air, calcining the charge, etc., was about 30,000 cu. ft./ton of reduced Fe. Data are given on the relative reducibility and gas utilization of 7 ores in the furnace. Sticking was overcome by pretreating the ore with about 25% of its weight of a suspension of slacked lime containing 5% of quicklime. Reducibility was increased by the treatment. C in reduced ores increased with completeness of reduction. Some S is eliminated during reduction; S can be reduced still more by roasting before reduction. AHE (2b)

8 **Shaft-Furnace Reduction by the Glomerule Method.** E. P. BARRETT. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 47-48. Glomerules formed from partly wetted ore by tumbling and heating to 1000°-1200° are readily reduced in a shaft furnace. AHE (2b)

9 **Note on Preparation of Pure Iron by Heating Briquets of Pure Iron Ore and Reducing Agent.** T. L. JOSEPH & E. P. BARRETT. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 48-49. A mixture of 80 grams magnetite (containing 0.3% SiO_2), 3 grams flour, 15 grams charcoal, and 15 grams H_2O briquetted under pressure of 6.34 tons/sq. in., dried at 105°, and heated in an induction furnace for 125 min. gave a high-purity, low C steel with a yield of approximately 78% of the Fe. AHE (2b)

10 **The Direct Production of Wrought Iron.** R. S. DEAN. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations* No. 3229, May 1934, pages 49-51. Sponge Fe produced at low temperatures is briquetted and heated to a temperature above the melting point of Fe silicate but below that of Fe. Solid Fe and molten silicate are formed. Most of the slag can be removed by hammering or rolling. In a single step process, briquets of ore and 15-18% reducing agent are passed through a muffle furnace, then hammered. With coal containing 0.8-1.0% S, S in finished Fe was 0.04%. Combined C was less than 0.05%, usually less than 0.02%. Upper limit of slag content was 25%. Lower % of reducing agent gave a less siliceous slag and more slag volume with better forgeability. The properties of the Fe were within specifications for commercial wrought Fe. AHE (2b)

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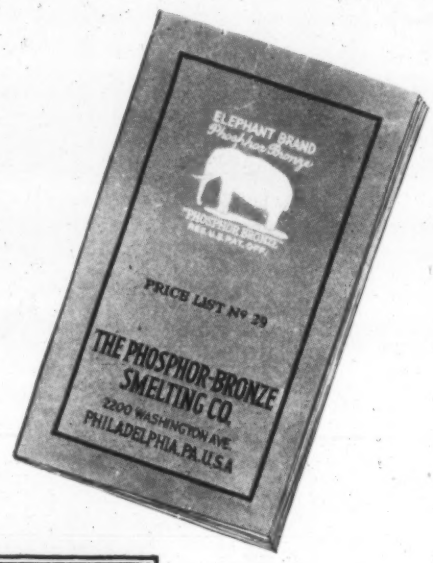

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Some Experiments on the Speed of Reduction Processes Encountered During Magnetizing Roasting Iron Quartzites from Krivoi Rog. V. I. KARMAZIN. *Domez*, No. 4, 1934, pages 47-59. (In Russian.) Apparatus is described in which the speed of reduction of quartzites is determined by the difference in volume of reducing gases, freed from H_2O, before and after reaction. A continuous and accurate check is possible. Optimum roasting range is 500°-550°C. The size of particles (0 to 10 mm) does not have a pronounced effect. The reduction to magnetite is completed at these temperatures within 10 minutes using either H_2 or CO. Temperature rise increases the speed of reduction but its influence is different with different reduction gases. CO reduces better than H_2 in the range 400°-450°C. but not at higher temperatures. Unreduced oxides (1-5%) did not affect the separation which was complete. The results agree in general with the data of the Experimental Station of the Bureau of Mines in Minneapolis. (2b)

Direct and Indirect Reduction in the Blast Furnace (Om den indirekta och direkta reduktionen i blästermasugnen). IVAR BOHM. *Jernkontorets Annaler*, Vol. 114, June 1934. pages 277-339. The purpose of the investigation was to compare the relative ease of reduction of various types of ore, sinters, and briquettes by CO under various operating conditions. A gas containing 30% CO, 0.4% H_2 and 69.6 N_2 was chosen as most representative of Swedish furnaces. This was passed through the ore suspended on a balance pan in a heated furnace at such a rate as to give 1%-2% CO_2 in the exit gas. During reduction the loss in weight of the ore was registered automatically, while the temperature was increased at a uniform rate from 300°C. to 1000°C. during 5½ hours. Native unroasted ores showed from 10-75% reduction and briquettes approximately 75% reduction, although their porosity was greater than several native ores which showed a good reduction. Roasted ores tended to show greater porosity and greater ease of reduction. Sinters prepared with 3.1% powdered charcoal showed 90.5% reduction as against 82.3% for sinters prepared with 4.8% charcoal. Coke was as effective as charcoal, but the finer powders in both cases markedly facilitated reduction. All ores, briquettes, or sinters gave more than 80% reduction when the particle size was reduced to 6-7 mm. Briquettes and sinters began to react at 350°-400°, and ores at 500°-600°. C deposition was not noted below 500°, and was inhibited by CO_2. Gas containing 28% CO and 2% H gave a small but definite increment in reduction, as was also noted when 13% CO_2 was added. The optimum briquetting temperature was 1,100°C., lower temperatures giving poor strength and higher temperatures low porosity. The Fe content of the briquettes had no influence. Several calculations are given indicating how ease of reduction modifies the C and fuel consumption of the blast furnace by minimizing the highly endothermic direct reduction. HCD (2b)

Use of Sponge Iron in Production of High-quality Steels in the Electric Arc Furnace. G. R. FITTERER & HYMAN FREEMAN. *Progress Reports—Metallurgical Division. 4. Studies in Direct Production of Iron and Steel from Ore. United States Bureau of Mines, Report of Investigations*, No. 3229, May 1934, pages 61-63. Two 4-ton heats of plain C tool steel were prepared: (1) 50% Swedish sponge Fe, 50% plain-C, tool-steel scrap, (2) 100% scrap not made from sponge Fe. The 2 steels analyzed, respectively: C 1.03, 1.00; Mn 0.34, 0.34; P 0.017, 0.018; S 0.011, 0.012; Si 0.34, 0.22; Ni 0.10, 0.03; Cr 0.14, 0.08; V 0.05, 0.08. Ingots from 1 were slightly more forgeable than 2. The as-cast ingots and 4 x 4 in. billets of 1 were slightly denser and harder than 2. Ultimate strengths and yield points of 2 were slightly greater than 1, regardless of heat treatment. Steel 1 showed greater percentages of elongation, reduction of area, and Charpy impact strength than 2, regardless of heat treatment. Steel 1 had a uniformly greater hardenability than 2. The lives of cold-heading dies are similar. The 2 steels differed more in their vibration-damping capacity than in any other property. In the annealed and normalized states the damping capacity of 1 was twice that for 2. AHE (2b)

Movement and Distribution of the Burden in a Blast Furnace. M. B. POSIN. *Domez*, 1934, No. 1, pages 19-27 (In Russian). With a narrow opening between the bell and the hopper material is thrown to the walls of the furnace. The relation between the thickness of charge at the wall and the opening of the charging device is shown. When the opening is large enough the surface of the charge presents two slopes. A mathematical expression for the shape of the charge is given. Burden settles faster in the center in furnaces with a narrower hearth and faster at the periphery in high production modern furnaces. Observations show that the burden settles in jerks instead of uniformly. Three times thicker layers at the periphery than in the center seem to be permissible. Uniform thickness of layers is not desirable. (2b)

Note on Cowper Stoves for Heating of Blast in Blast-Furnace (Note sur les Appareils Cowper pour le Chauffage du Vent des Hauts-Fourneaux). L. BOVET. *Arts-et-Métiers*, Vol. 87, June 1934, pages 131-139. Cowper stoves are described and computations for designing them are given. The following points are considered: (1) Thermal efficiency and fuel consumption, (2) sectional size of combustion chamber, (3) size, weight and volume of brick checkers, (4) heating surface, (5) size of openings in checkers, (6) disposition of checkers, (7) section of passage for blast, and (8) thickness of walls. FR (2b)

Melting Orsk-Halilov Ores at Kosogorski Blast Furnace Plant. N. N. INSHAKOV. *Domez*, No. 6, 1934, pages 1-13. (In Russian). Very detailed description of melting practice and results obtained on melting laterite ore containing 0.5% NiO and 2.5% Cr_2O_3. Fe with an average of 0.75% Ni and 2.75% Cr could be obtained without difficulty, but the commercial results were unsatisfactory. (2b)

The Liu Ho Kow Blast Furnace Plant, Hankow. T. C. CHEN. *Far Eastern Review*, Vol. 30, Mar. 1934, pages 117-121. Descriptions of Chinese plant. 17 illustrations. WH (2b)

The Dagenham Blast Furnace. *Engineer*, Vol. 158, Aug. 10, 1934, pages 135-136. Description with illustrations and plan of the blast furnace of the Ford Motor Co., on the banks of the Thames. It is capable of producing 500 tons of pig Fe/day and is now using 32,000 cu. ft. of air/min. in making 300 tons. The iron is a high-Si type of metal and is used in the company's foundry. LFM (2b)

Viscosity Study of Molten Titanium Slags. M. P. VOLAROVITCH & L. V. ZVEREV. *Domez*, No. 5, 1934, pages 22-29 (In Russian). Viscosity was determined in an apparatus in which 2 Pt-Ir concentric cylinders were immersed in the molten slag heated in a furnace with Pt-Ir windings. The inside cylinder was mounted on an axle supported in roller bearings and was rotated by weights. The outside cylinder was stationary. Pt-Ir was used to prevent the gliding observed with graphite cylinders due to CO bubbles generated on their surface. At low viscosities the results with synthetic slags checked closely the data of McCaffery (AIMME, Tech. Pub. 383) and was somewhat higher than the data of Feild & Royster (U. S. Bureau of Mines, Tech. Papers 157-187 and 189). With lower temperatures and high viscosities the results obtained were much higher than the data of McCaffery because the gliding on the surface of the cylinders was eliminated. The viscosities of a glass, an average blast furnace slag and a Ti slag obtained in smelting titano-magnetite in a blast furnace with NaCl were compared. The slope of the viscosity curve for glass was the least, for Ti slag it was almost a vertical line and for ordinary slag it occupied an intermediate position. The viscosity of the Ti slag measured from 1400° C. down was very small, less than 5 poises, until the temperature of 1355° C. and 1320° C. were reached, after which the viscosity in the interval of 10°-20° C. increased a thousandfold due to the beginning of crystallization. Two Ti slags had the respective compositions: SiO_2 18.7, 20.0; Al_2O_3 12.6, 15.5; TiO_2 36.2, 31.5; CaO 14.7, 13.4; MgO 9.9, 10.6; FeO 3.8, 2.3; MnO 5.4, 5.2; Na_2O 2.5, 2.1; S 0.5, 0.4. (2b)

MELTING, REFINING & CASTING (3)

Template Molding of an Intermediary Piece (Schablonieren eines Zwischenstückes). F. VOGELSANG. *Die Giesserei*, Vol. 21, Aug. 17, 1934, pages 352-353. Describes templet and procedure which resulted in cheaper pieces than made from a pattern. Ha (3)

Effect of Carbon Dust in Molding Sand (L'Impiego Dei Neri in Fonderal). M. PASCHKE & EUGEN SCHNEIDER. *L'Industria Meccanica*, Vol. 16, July 1934, pages 571-576. See "Action of Coal Dust in Molding Sand," *Metals & Alloys*, Vol. 5, July 1934, page MA 312. Ha (3)

Making of a Particularly Difficult Casting (Die Herstellung eines besonders schwierigen Gussstückes). H. OVERBECK. *Mitteilungen aus den Forschungsanstalten des Gutehoffnungshütte-Konzerns*, Vol. 3, Aug. 1934, pages 102-103. Detailed description of molding of 4 m. length, 2.8 m. width, weight 7.5 tons, cast weight 10 tons. Casting contains 48 cores for valve seats. Pouring required only 45 seconds due to a special method of pouring. Ha (3)

Three Different Ways of Molding a Base Plate by Sweeping (Trois Modes d'Exécution d'un Soubassement au Trousseau). L. LOEWER. *Revue de Fonderie Moderne*, Vol. 28, July 10, 1934, pages 189-192. Full description of procedures; translated from a source not given. Ha (3)

Mass Effect and Quality in Steel Making. JOHN H. HRUSKA. *Iron & Coal Trades Review*, Vol. 129, July 13, 1934, page 43. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 434. Ha (3)

Mechanical Precision Molding, Influence of Molding Boxes (Le Moulage Méchanique de Précision, le Rôle des Chassis). G. ITAM. *Revue de Fonderie Moderne*, Vol. 28, June 25, 1934, pages 182-185. Design and proper machining of molding boxes are very important points to be observed if long life is to be assured; differences in machine molding and hand molding are pointed out. Replacement of cast iron by steel molds have often given good results in spite of higher first cost which was soon offset by longer life. Ha (3)

Oven Drying of Cores and Molds. E. G. FIEGEHEN. *Mechanical World & Engineering Record*, Vol. 95, June 29, 1934, pages 626-628. Abstract of a paper presented to the 31st annual conference of the Institute of British Foundrymen, June 5 to 8, 1934. Discussion of processes which take place when cores are dried. The author shows that drying must take place in three stages: (1) constant rate drying, (2) saturated surface drying, (3) sub-surface drying. There must be air spaces between the grains of sand to permit rapid drying without distortion of the cores or molds. The amount of binder present should therefore be sufficient to obtain adhesion but not enough to fill the voids. Kz (3)

Artistic Castings (Aus der Praxis des Kunstgusses). ERICH BECKER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, July 22, 1934, pages 307-309; Aug. 5, 1934, pages 327-330. Author discusses the 3 methods used in molding art castings (1) by means of lost molds, (2) with elastic molds, (3) with wedge pieces. Preparation of the gypsum patterns, subdivision of gypsum patterns, enlargement or reduction of art casting patterns are considered. GN (3)

Physical Change in Metals in Repose. The Theory of Degasification. E. E. G. BRADBURY. *Iron & Steel Industry*, Vol. 7, Mar. 1934, pages 193-194. Author states that advantages accruing from castings remaining in a yard over a period of time exist in spite of rather than because of weathering. Logical reasoning is made to substantiate the suggestion that gases of various types continue to escape from the castings long after they have reached atmospheric temperature. Further investigations are considered advisable. CEJ (3)

A Cover Made by Template Molding (Eine Haube nach Schablone). H. ECKART. *Die Giesserei*, Vol. 21, Aug. 31, 1934, pages 373-374. Describes method of molding by templates of a large cover of 2 m. outside diam., 600 mm. height and average 50 mm. wall thickness. Ha (3)

Pattern Cost Calculation and Piece Work in Pattern Making (Modellkostenvoranschläge und Stücklohnarbeit im Modellbau). ARNO. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, June 10, 1934, pages 249-251. Outlines most suitable and economic methods of making the patterns of a roll. GN (3)

Development of Core Blowing Machines. Sand-Air Mixing System, an Improved Core Blowing Method. (Die Entwicklung der Kernblasmaschinen. Das Sand-Luft-Mischsystem ein verbessertes Kernblasverfahren). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 29, 1934, pages 465-466. After discussing the historical development of core blowing machines the modern machines of Vogel & Schemmann Hagen-Kabel are described. Advantages derived from use of such machines are enumerated. The production capacity of automatic core blowing machines amounts to at least triple that of a trained core maker. GN (3)

Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

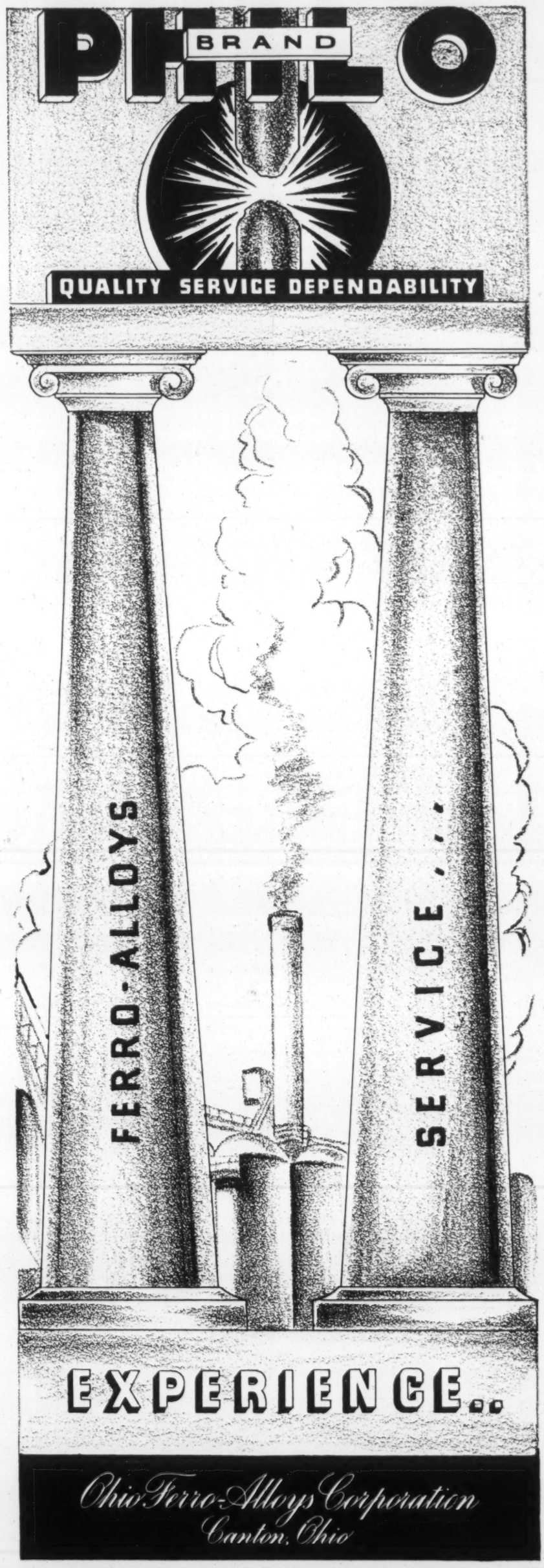
Porosity in Non-Ferrous Metal Castings. G. L. BAILEY. *Foundry Trade Journal*, Vol. 50, Mar. 15, 1934, pages 175-178. See *Metals & Alloys*, Vol. 5, July 1934, page MA 315. OWE (3a)

Secondary Aluminum. ROBERT J. ANDERSON. *Canadian Chemistry & Metallurgy*, Vol. 18, Aug. 1934, pages 183-184, 186. Secondary Al is defined as pig metal obtained by melting scrap or waste Al. Liquation and special fluxing methods reduce certain metallic impurities, while Zn and Mg may be "burnt out" in part by high heating. Furnacing and fluxing methods are varied according to the type of material melted. Ten types of raw material are listed and applications of this metal noted. See also *Metals & Alloys*, Vol. 2, Nov. 1931, page 285. WHB (3a)

Molding and Casting of Boxes of Acid-Proof Alloy for Pressing Copper Ore Bricks (Formen und Giessen von Steinpresskasten aus säurebeständiger Legierung). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, July 22, 1934, pages 309-310. Such boxes as used for pressing copper ores into briquettes were made of an alloy containing 77.5% Cu, 5.6% Sn, 7.5% Pb, 2.6% Sb and 6.8% P-Cu. In molding it is highly important to use dry sand since porosity of the casting necessarily results if this precaution is not observed. The casting was molded in 3 parts and cast with a horn gate without riser. The casting procedure applied is outlined, the casting temperature should not be below 1150°C to avoid cracks. GN (3a)

The Perrin Process. (Perrin-processen). HARRY WILLNERS. *Jernkontorets Annaler*, Vol. 118, May 1934, pages 229-248. General discussion of a process for dephosphorizing iron by pouring into a vigorously stirred dephosphorizing slag. HCD (3a)

How to Avoid Shrinkage Occurrences (Cavities, Piping, Segregations) in Non-Ferrous Metal Castings (Wie verhindert man Schwindungserscheinungen (Saugen, Lunkern, Seigern) beim Metallguss). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, May 27, 1934, pages 225-227. Defects of physical nature (shrinkage cavities, piping, segregations) appear to a much greater extent in non-ferrous metal castings than in gray Fe castings. The reasons of these occurrences are first considered and the methods of eliminating them are outlined with special reference to suitable molding technique. Risers must be high enough and so arranged that the static metal pressure is effectively utilized. Uniform crystallization throughout the whole casting is important. This can be attained by arrangement of special cooling bodies. Practical examples of application of such cooling bodies are given. Cooling nails and cooling pins are sometimes used to advantage instead of cooling plates. Importance of proper casting temperature is finally stressed. GN (3a)



On the Application of Copper-, Bronze-, and Brass Scrap in the Foundry (Zur Verwendung von Kupfer-, Bronze-, und Messingabfällen in der Giesserei). E. R. THEWS. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, June 10, 1934, pages 245-247. Author discusses a number of points to be observed in adding scrap metal in melting the above mentioned metals and alloys. Grading of scrap by various methods, impurities and their removal are considered. As a rule all types of secondary metals and alloys should never be used in raw state. If careful purification of such scrap cannot be accomplished it is always possible to improve it by slight oxidation and subsequent deoxidation with P-Cu. These preliminary raw alloys are free of dirt and oxides, their composition can be determined so that they can be used for the purpose desired. Advantageous use of large remelting and refining units of old material is finally stressed. GN (3a)

Newest Developments in and Present Status of the Electrolysis and Refining of Nickel with Special Reference to the German Situation (Neueste Entwicklung und augenblicklicher Stand der elektrolytischen Gewinnung und Raffination des Nickels unter besonderer Berücksichtigung der deutschen Verhältnisse). WALTER SAVELSBERG. *Metall und Erz*, Vol. 31, May 1934, pages 222-226. Description and discussion of the Orford, International Nickel Co's., Haglund, and electrolytic process of the Allgemeine Elektro-Metallurgische Gesellschaft using a chloride solution. Abbreviation of a lecture before the Gesellschaft Deutscher Metallhütten-und Bergleute. CEM (3a)

Difficulties in Production of Aluminum Bronze Castings (Schwierigkeiten bei der Herstellung von Aluminiumbronzeguss). E. T. RICHARDS. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, June 24, 1934, pages 265-267. Paper deals with the difficulties due to changes in crystal structure upon cooling. To avoid these structural changes 3 different possibilities are discussed (1) casting in Fe molds, (2) casting in sand molds removal of casting from mold immediately after freezing, (3) adding to alloy 3-4% Fe or Ni. The advantages and disadvantages of these various methods are outlined. Usefulness and advantage of adding Mn to Al bronze is finally pointed out. GN (3a)

Manufacture of Sulphur Free Bronze Alloys (Zur Herstellung Schwefelfreier Bronzelegierungen). E. T. RICHARDS. *Chemiker-Zeitung*, Vol. 58, May 16, 1934, pages 402-403. Some bronzes which are made from scrap metals contain as high as .2% S. This is objectionable. Low S alloys can be obtained by: 1. use of pure metals and correct melting to prevent S absorption, 2. removing or reducing the S by remelting scrap in a pit furnace, 3. reducing the S by treating in a reverberatory furnace. In the pit furnace the S can either be increased by use of high S coke or decreased by use of charcoal, acid slag, or by addition of Mn ore or Na_2CO_3 and NaOH. In the reverberatory furnace the S is reduced by addition of a mixture of Na_2CO_3 and powdered charcoal. The complete removal of S from bronze has not been properly solved. CEM (3a)

Production of Crude Copper from Scrap Brass by Blowing in a Basic Converter (Herstellung von Rohkupfer aus Altmessing durch oxydierendes Verblasen im basischen Konverter). GOTTHARD E. LENK. *Metall und Erz*, Vol. 31, June 1934, pages 244-251. Brass or bronze scrap is melted and blown in a converter with the addition of sufficient Fe so that the low melting metals are oxidized and the high melting remain. SiO_2 sand is added to aid in fluxing. 85% of the Cu can be recovered as 97.5 to 99% pure Cu free from Zn, and 80% of the Zn as ZnO. Ni and Ag remain with the Cu. The weight of Fe and blowing time are varied according to the composition of the scrap. Usually about 10% Fe is used. It furnishes most of the heat, but some coke is also added. Fe also prevents the oxidation of Cu, which does not oxidize until the Fe is completely oxidized. The slag formed consists mostly of oxides or ferrites. The reduction to FeO, which lowers the viscosity, can be prevented by small additions of CaO and SiO_2. CaO also drives ZnO out of the slag so that it can be recovered. A small amount of coke added just before drawing off the slag increases the yield of Cu. The 15% Cu which is not recovered goes into the slag. When Sn bronzes or alloys containing Sb are blown the Cu yield is only 40-60%. With CaO additions the Zn yield is 80%, without it is 40-60%, the balance going into the slag. The slag amounts to about 40% of the weight of the charge. 95% of the Pb and Sn is oxidized and volatilizes or goes into the slag. Low Sb content does no harm, but high Sb oxidizes very slowly and not completely. Another process should then be used. The dust blown out of the converter is 90% ZnO, the balance PbO and SnO. The converter is lined with magnesite. The coke should be charged into the hot converter first and blown until it begins to burn. Then the brass and Fe are added slowly, requiring 1 hour, the blast increased over ¼ hour and blown for 1 hour. Then the slag is drawn off and the Cu tapped. The total time is 4 hours for a 3-4 ton charge. 25 references. CEM (3a)

Refining of Scrap Nickel (Zur Raffination von Altnickel). HERBERT HERMANN. *Chemiker-Zeitung*, Vol. 58, June 13, 1934, pages 481-482. The main impurities in Ni are S, O, CO, C, and Si, of which S is the most important, as it makes Ni brittle. Mg is added to molten Ni to remove S and O, .12 to .15% being sufficient. An excess of Mg should not be used. If the Ni does not contain S it can be deoxidized with Mn. The metallic impurities are not important. A reverberatory furnace with basic lining and low S fuel may be used, or a clay or graphite crucible, gas or oil fired, in which the gas absorption is less, or an electric furnace. The furnace should be fired as hot as possible before charging. During the first period after melting, about 1 hour, the Ni is oxidized and most of the impurities are removed during this time. Then the Mg is added. As, Zn, Fe, Si and C are removed by oxidation, S, oxides and carbides by the Mg. Pb is difficult to remove. If it is present the oxidation period must be increased or twice as much Zn as Pb present is added, which aids in eliminating Pb. If the Ni is badly oxidized .1% Mg and .2% Mn should be added. The bend test is useful for checking the purity after refining. CEM (3a)

Ferrous (3b)

C. H. HERTY, SECTION EDITOR

Production of Pure Iron and Nickel (Die Reindarstellung von Eisen und Nickel). F. WINTER. *Die Metallbörse*, Vol. 23, July 29, 1933, pages 957-958. An electrolytic method of preparing pure Fe from Fe-chloride solutions is still in the experimental stage. A commercial German process is based on the decomposition of Fe carbonyl below 400° or above 900° C., whereby low amounts of NH_3 act as catalyzer. The preparation of highly pure Ni from Ni carbonyl is compared with the customary refining process. The deposited Ni has a grain size of .5-5 microns and contains less than .05% C + O_2. Sintering at 1200° C. or working in a H_2 atmosphere yields Ni of the following physicals: Brinell = 90, tensile strength = 40 kg./mm.², elongation = 50%. Winter claims that highly pure Ni is especially suited for anodes, electric wire, welding rods, sheets and high-grade alloys. EF (3b)

Making Axle Steel at the New Open Hearth Shop of Makejevka Works. M. A. TATAROV. *Domez*, No. 7, 1934, pages 20-27. In Russian. As long as the four 150 ton open hearth furnaces built in this plant were making soft steel, no particular troubles were observed. When an order for 50,000 tons of axle steel, 0.25-0.40% C, 0.5-0.8% Mn, 0.2-0.4% Si was received, for the first 3 months of production all metal made was scrapped. For the next month the yield was 21% of the ingots teemed, the next 34% and at the present attempts are made to reach 40% yield. Steel is scrapped on account of deep longitudinal cracks on ingots. They weigh 7 tons and are cast in straight walled, big end down molds without sink heads. Careful analysis of the factors entering the steel making practice which might have some influence on cracking is given. No definite conclusion regarding the cause of cracking is offered. (3b)

Surface Phenomena during Cooling of Cast Iron (Phénomènes superficiels au refroidissement de la fonte). SARRA. *Usine*, Vol. 43, Aug. 9, 1934, pages 27, 30. When liquid cast iron cools from about 1450°-1500° to 1375° C. C alone absorbs O from the air and forms a protective film under which the liquid metal remains clean. At 1375°, a very fine film of a slag covers for short time the metal which appears as a network on the surface and can be clearly observed in a photograph. From the appearance of photographs of the surface during cooling the author tries to find relations with the properties and composition of cast iron. Ha (3b)

On the Application of Chill Molds in the Malleable Foundry (Ueber das Anlegen von Kokillen in der Tempergiesserei). W. SCHNEIDER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 5, 1934, pages 321-323. Author first discusses the various causes of crack formation in malleable castings. Two methods of processing the pivot couplings of the driving mechanism of a grass mowing machine are then described. In the first method suction ports were arranged on each pivot to avoid piping. The second method to attain this end applies chill molds. The latter is more economic, the melting costs are lower since the considerable amount of metal used for the suction ports can be saved. Another advantage of this method is saving of the machining costs. By using the chill molds the pivots are smooth and true to dimensions. GN (3b)

Making Ball Bearing Steel. J. A. SCHULTE. *Domez*, No. 7, 1934, pages 13-20. In Russian. C-Cr steels used for ball bearings and races are made in basic electric arc furnace to meet severe specifications. The methods for conducting a heat are given in full. When the charge is melted the slag is skimmed off and a second black slag is produced by letting the bath boil vigorously and adding to it ore and limestone continuously. The slag runs over the sills. After skimming it when carbon is about 15-20 points above the desired finishing figure, carbide slag mixture is charged in and the heat finished as usually under a black (sic) carbide slag. (3b)

Evolution of the Refining Process of Steel (L'évolution dans les procédés d'épuration de L'acier). A. PORTEVIN. *Métaux* (formerly *Aciers Spéciaux, Métaux et Alliages*), Vol. 9, Mar. 1934, pages 84-92. A general review of application of physical chemistry to steel making and a description of Perrin process of steel refining by means of artificial molten slags. GTM (3b)

Sulphur Content of Cast Iron. A. NEHMITZ. *Foundry Trade Journal*, Vol. 50, Mar. 29, 1934, page 208. See "Content of Sulphur of Cast Iron as Function of Duration of Melting of the Cupola Furnace," *Metals & Alloys*, Vol. 5, July 1934, page MA 320. OWE (3b)

Effect of Silicide, Phosphide and Carbide Formation in Iron-rich Melts on Their Equilibrium with Oxides (Die Auswirkung der Silizid, Phosphid und Karbidbildung in eisenreichen Schmelzen und ihre Gleichgewichte mit Oxyden). FRIEDRICH KÖRBER & WILLY OELSEN. *Die Naturwissenschaften*, Vol. 22, June 1, 1934, pages 395-398. Results on laboratory experiments are graphically presented. The Si contents of an Fe-rich melt at 1600° C. in relation to Mn content are established for the equilibria liquid Fe-liquid MnO-FeO silicates—solid SiO_2. The SiO_2 isotherm shows the max. Si contents which can be reduced from solid SiO_2 by Fe and Mn at 1600° C. The formation heat of Fe-Si alloys has been determined and the chemical reactivity of Fe and Mn in relation to Si content were investigated. The effects of increasing P contents (0-17.5%P) at 1600° C. and of C (0-4% C) at 1500° C. upon the course of the Si isotherm are experimentally determined. P content of about 15%, Mn-bearing Fe is hardly able to reduce solid SiO_2 to Si. The phosphides Fe_3P and Mn_3P are formed instead. In spite of the high P contents (up to 20% P) of the melt, the occurring silicate slags are very low in P_2O_5 (0.08-0.5%). During the oxidation (air, Fe oxides) of Fe, which contains P, C, Mn and Si, the formation of solid SiO_2 occurs at much lower Si contents than in melts of equal Mn contents but free from P and C. EF (3b)

Determination of Oxygen in Alloy Steels and Its Effect Upon Tube Piercing. NEWELL HAMILTON. *Steel*, Vol. 94, Mar. 5, 1934, pages 28, 30. See *Metals & Alloys*, Vol. 5, July 1934, page MA 320. MS (3b)

Producing Gray Iron in Acid Electric Furnaces. CLYDE L. FREAR. *Iron Age*, Vol. 1932, Aug. 17, 1933, page 18. See "Gray Iron Production in the Direct Arc Acid-lined Electric Furnace," *Metals & Alloys*, Vol. 5, July 1934, page MA 319. VSP (3b)

Studies on Solidification and Contraction and Their Relation to the Formation of Hot Tears in Steel Castings. C. W. BRIGGS & ROY A. GEZELIUS. *Foundry Trade Journal*, Vol. 49, Sept. 21, 1933, pages 157-160; Sept. 28, 1933, pages 173-174; Oct. 5, 1933, pages 193-195. **Cause and Prevention of Hot Tears in Steel Castings.** *Iron Age*, Vol. 132, Sept. 28, 1933, page 35. See *Metals & Alloys*, Vol. 5, July 1934, page MA 319. VSP + OWE (3b)

The Status and Tendencies of Method of Analysis and Identification of Non-Metallic Inclusions in Ferrous Materials (Etat et Tendances des Methodes de Dosage et d'Identification des Inclusions non-Metalliques dans les Produits Ferreux). R. CASTRO. *Chimie et Industrie*, Vol. 31, Mar. 1934, pages 514-521. Includes discussion. Non-metallic inclusions in steel are usually complex oxides and sulphides and are considered detrimental. The analysis of these bodies may be done by either a direct or an indirect method. The latter consists in the use of a reducing agent (H or C) to determine the composition of the bodies. In the direct method the residues are analyzed after decomposing the metal with an acid, a halogen or an electrolytic agent. The latter, i.e., the direct method seems to the author to be the one for future use. MAB (3b)

Economic Considerations of the Open-Hearth Process. Factors Pertaining to Efficiency. *Iron & Coal Trades Review*, Vol. 129, Aug. 3, 1934, page 153. In considering the efficiency of an open-hearth furnace its operation alone is not determining, it must start with the production of the fuel gas and end with the waste heat; the gas must be generated in the most economic manner and the products of combustion utilized to the fullest possible extent. These points are discussed and illustrated by a modernized equipment of the Yorkshire Steel works. Ha (3b)

Processing of a Diving Bell (Herstellung einer Tauchglocke). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 5, 1934, pages 331-335. Detailed discussion of the procedure applied in molding in loam a diving bell, 950 mm. in diameter, 1100 mm. high. GN (3b)

Alloying of Cast Iron with Nickel and Chromium (Ueber das Legieren von Gusseisen mit Nickel und Chrom). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Aug. 5, 1934, pages 323-324. Discusses the practice applied in alloying Ni and Cr to cast Fe (1) adding in ladle or on furnace spout, (2) alloying in cupola. GN (3b)

Sweep Molding in Loam of a High Pressure Cylinder (Formen eines Hochdruckzylinders mit Schablonen in Lehm). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, July 8, 1934, pages 291-295. The steam engine cylinder described was molded in loam. Making of the mold is outlined in detail. The cylinder was molded in vertical position with sink head. By this molding procedure a top flask was not required, core work was simplified. GN (3b)

The Occurrence of "Blisters" in Tinplates, with Special Reference to Original Ingot Structure. T. G. GREY-DAVIES. *Sheet Metal Industries*, Vol. 8, Sept. 1934, pages 507-509, 514. It is shown that the production of an ingot with a thick, sound "skin" tends to eliminate blisters so that "waster plates" are cut to a negligible figure. Pouring at a slow rate of 40 lb. per second as a means of producing thick skin is discussed. Rimming steels are discussed. It is pointed out that careful handling of even thick-skinned ingots is essential to the production of fine plates. AWM (3b)

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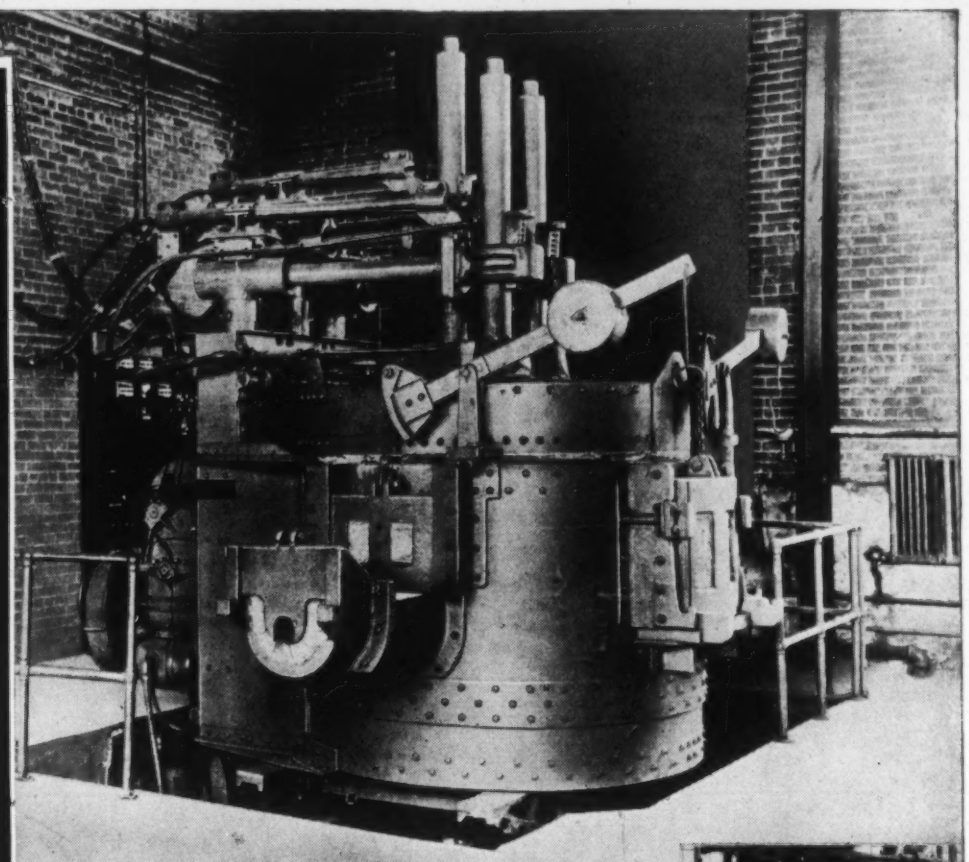

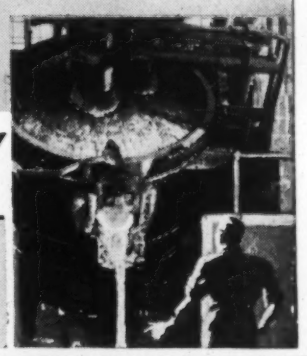

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WORKING OF METALS & ALLOYS (4)

The Manufacture of Copper Firebox Plates. *Journal Institution of Locomotive Engineers*, Vol. 24, Jan.-Feb. 1934, pages 128-141. A discussion in Perth, Western Australia, of a paper by W. F. BRAZENER. The relative qualities of pre-war and post-war copper, the effect of arsenic in copper, and shop practice in annealing, flanging, and machining firebox plates were among the points discussed. In his reply, author suggests than an improvement in the purity of firebox copper from 99.0 to 99.2% minimum may have affected wearing properties but states that records of mechanical tests show no change over 40 yrs. and suggests that more severe service conditions may account for much of increased failures in recent times. JCC (4)

Rolling (4a)

RICHARD RIMBACH, SECTION EDITOR

Electrical Preheating of Hot Rolls in Thin Plate Rolling Mills (Das elektrische Vorwärmen der Warmwalzen in Feinblechwalzwerken). ROSE. *Die Wärme*, Vol. 57, June 2, 1934, pages 356-357. See *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 22. EF (4a)

Manufacture of Full-Finished Steel Sheets. ERIC R. MORT. *Sheet Metal Industries*, Vol. 8, July 1934, pages 393; Aug. 1934, pages 453-454; Sept. 1934, pages 513-514; *Iron & Coal Trades Review*, Vol. 128, June 1, 1934, pages 883-886; June 15, 1934, pages 926-927; June 22, 1934, pages 968-969, 972; *Machinery*, London, Vol. 44, June 14, 1934, pages 314-316; June 28, 1934, pages 380-382. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. AWM + Ha + Kz (4a)

Investigation of the Causes of Rough Surface Formation on Black Plate. N. J. TEITZ, M. I. TSHEPAK, N. P. SMOLYANOV & G. B. LAVDANSKI. *Domez*, No. 6, 1934, pages 21-30. In Russian. The yield for all Russia of prime tin plate, starting with the sheet bar, was 13.7% in 1931 and 15.6% in 1932. Most rejections were due to rough surface. Comprehensive investigation in the plants showed that the roughness depends primarily on the location of the blow holes in the ingots, the influence of which is intensified by overheating of the sheet bars before rolling. Heating of pairs, etc. has a slighter effect. Other stages of manufacturing processes do not affect roughness at all. (4a)

Unique Rolling Mill Drive. *Iron & Coal Trades Review*, Vol. 129, July 13, 1934, page 54. Describes a helical gear drive for a large sheet rolling mill; reduction from 1800 r.p.m. motor speed to 35 r.p.m. roll speed; total weight of gear 82 tons. Maximum 10800 h.p. (= 6 times normal). Ha (4a)

Flexibility as a Factor in the Economic Exploitation of Rolling-mills and Some Technical Means for its Realisation. GEO. A. V. RUSSELL. *Iron & Steel Institute, Advance Copy* No. 11, Sept. 1934, 92 pages; *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, pages 363-369 (abstract). Flexibility is defined as the ability to maintain relatively uniform earnings over a wide range of operation or when producing a wide range of products. Ingot production and production of individual rolling mills during the past few years are discussed and it is concluded that flexibility is becoming increasingly important. The major elements making up an ordinary rolling mill are considered from the standpoint of obtaining the greatest degree of flexibility. Actual mills are then described and desirable mills outlined. The fundamental principles underlying the design and operation of commercially successful flexible rolling mill plants are established and the general applicability of such plants discussed. Ha + JLG (4a)

First Continuous Sheet Bar Mill in USSR. J. BERGER. *Domez*, No. 7, 1934, pages 27-39. In Russian. Detailed description of the mechanical features of the proposed installation. (4a)

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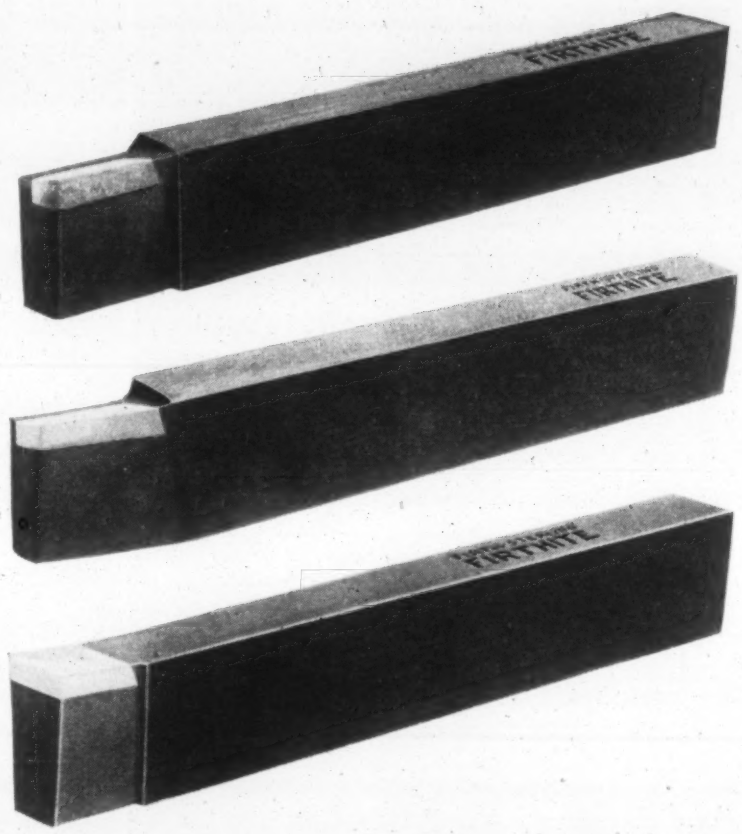

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Machining (4d)

H. W. GRAHAM, SECTION EDITOR

1 **How to Select the Best Kind of High Speed Steel for Machine Work.** KAN-ICHI YAMAGUCHI. *Journal Society of Mechanical Engineers*, Vol. 37, Apr. 1934, pages 202-205. In Japanese. Paper read before the 243rd meeting of the Society of Mechanical Engineers, Nov. 15, 1933. The author concludes from his experience: (1) No single cutting material is adapted for all kinds of tools or purposes, (2) Low Co high speed steel (W 18%, Cr 4%, Co 1.5%) has been found better adapted for screw machine work than any other grade of high speed steel, (3) High Co high speed steel (W 18%, Co 10%) is recommended for rough turning tap steels or any other C tool steel, (4) Tungsten carbide is the most economical cutting material for tools for turning cast iron and gun metal, (5) For most uses others than those mentioned, common high speed steel (W 18%, Cr 4%, Co 0.8%) is most economically adapted. Kz (4d)

2 **Shaving Dies for Smooth-Edged Blanks.** L. PICKETT. *Machinery*, N. Y., Vol. 40, Aug. 1934, pages 709-712. Points on design, care and operation of shaving dies used in the production of parts for calculating machines and scientific instruments are discussed. Ha (4d)

The Economical Production of Form Milling Cutters. A. MOUGEY. *Modern Machine Shop*, Vol. 7, Oct. 1934, pages 20-24. Description. Ha (4d)

3 **Machinability Properties of Heat-Treated Structural Steels (Zerspanungs-Eigenschaften wärmebehandelter Baustähle).** W. LEYENSETTER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 15, 1934, pages 1085-1087. Testing methods are described to determine the change in machinability and wear-resistance of structural steel which has been subject to a heat-treatment; the change was measured by the pendulum test and the pressure required for cutting. Test results are shown in curves and micrographs; this mode of testing has been found to be suitable to determine the most favorable heat-treatment for a given steel. Ha (4d)

Broaching Independent Front-Wheel Suspension Parts. WM. A. HART, *Machinery*, N. Y., Vol. 41, Sept. 1934, pages 1-8. Machining and finishing processes by broaching and new applications and equipment are described. Ha (4d)

English Tool Steels Differ in Some Respects from American and Continental. W. H. HATFIELD. *Metal Progress*, Vol. 26, Sept. 1934, pages 41-42. Comments upon the compositions of plain, non-deforming, finishing and high speed tool steels used in England. WLC (4d)

4 **Cutting Steel with Tantalum Carbide.** J. M. HIGHDUCHEK. *Machinery*, N. Y., Vol. 40, Aug. 1934, pages 737-738. Examples of successful application in different cases are described. Speed is as high as 120 ft./min. at a feed of 0.031 in. Ha (4d)

The Choice and the Use of Hack-Saw Blades. G. C. GRANT. *Mechanical World & Engineering Record*, Vol. 95, Mar. 30, 1934, pages 308-310. Discussion of the manufacturing process and composition of material of 2% W saws to show which factors affect the finished product. To assist the user in the choice of the right type of saw blade, tables are given presenting tests on hacksaws of various makes cutting different kinds of steel. Kz (4d)

5 **Cutting Oils, Their Relative Value.** L. BALLARD. *American Machinist*, Vol. 78, Aug. 15, 1934, pages 560-563. The function of cutting oils, i.e., to provide lubrication between tool and work, dissipate heat, minimize power consumed, increase life of tool and assure good finish, is discussed and the various oils used are described. Selection of oils depends on character of work to be done. Measures for avoiding corrosion of work and skin infection of the workmen should be taken and are described briefly. Ha (4d)

Progress in the Hard Metal Field (Fortschritte auf dem Hartmetallgebiet). KARL BECKER. *Metallwirtschaft*, Vol. 13, Aug. 10, 1934, pages 565-566. Discussion of patents issued during the last few months covering hard metals for cutting tools. CEM (4d)

6 **Science and Practice in Metal Cutting.** E. BICKEL. *American Machinist*, Vol. 78, Oct. 10, 1934, pages 693-697. Best conditions for cutting of metals require best utilization of tool, best utilization of machine, and the economic optimum which is reached when a maximum weight of chips has been produced in a certain time. It is shown that metal cutting has become an extensive technical science but that the task of finding methods of organization which allow transfer of this science into practice is not yet fully accomplished. Ha (4d)

Tool Life for Minimum Cost. ROB. C. DEALE. *American Machinist*, Vol. 78, Aug. 15, 1934, pages 569-572. A mathematical method is developed for determining the most efficient tool life to use for any particular set of conditions on any metal-cutting operation. Proper application may lead to a reduction of machining cost. Ha (4d)

7 **What a Shop Executive Should Know about Cutting-Tool Materials.** R. C. DEALE. *Machinery*, N. Y., Vol. 40, Aug. 1934, pages 729-730. Carbon and high-speed steels, stellite and carbide tools in their general application for different purposes, and the view points for their selection are reviewed. Composition and properties of Co, Mo, W steels are described. Ha (4d)

Interesting Machining Operations at Newport News. H. CAMPBELL. *Modern Machine Shop*, Vol. 7, Oct. 1934, pages 9-17. Equipment and machining methods for large pieces in the Newport News Shipbuilding & Dry Dock Co. are described. Ha (4d)

8 **Low Cost Tooling.** HECTOR J. CHAMBERLAND. *Mill & Factory*, Vol. 13, Dec. 1933, pages 37-40, 69. Dealing with practical methods for reducing manufacturing costs advantages of steel welded constructions are discussed. Considering Cr plating and its effects on tool life and efficiency, the author says that the life of cutting tools such as drills, reamers, taps, dies, broaches, milling cutters, files, can be increased from 300-600%; all types of gages will last from 5-10 times longer if Cr plated. Discussion of steel treatment before plating. Nitriding steels are recommended for drill-bushings, lathe and grinding centers, aligning bars and parts of jigs and fixtures exposed to severe wear and abrasion. Kz (4d)

Electro-magnetic Feeds for Machine Tools. H. C. TOWN. *Machinery*, London, Vol. 44, May 17, 1934, pages 187-190. Discussion of advantages from the standpoint of simplification of design and ease of control. Kz (4d)

9 **Sharpening of Hard-Metal Tools (Das Schärfen von Hartmetallwerkzeugen)** F. SCHWERDTFEGER. *Oberflächentechnik*, Vol. 11, May 15, 1934, page 115. Grinding of hard metals (e.g. Widia, tungsten-carbides) can be done only with silicon-carbide. Raw-grinding, finish-grinding and lapping require quite different grinding materials. Grains must not be too coarse for the first process, medium-coarse and finer for finishing, and finest grains, especially diamond dust in bakelite or rubber for lapping; diamond wheels must run at 5000-10000 r.p.m. and about 25 m./sec. Excessive heating must be avoided. Practical hints are suggested. Ha (4d)

Precision Indexing Jigs for Boring, Drilling, and Tapping Heavy Work. D. STRAUCHEN. *Machinery*, N. Y. Vol. 40, June 1934, pages 600-604. Describes special indexing features of machines for boring, drilling and tapping heavy machine members by jigs. Ha (4d)

10 **Form-Turning on Vertical Turning and Boring Mills.** M. M. MCCALL. *Machinery*, Vol. 40, June 1934, pages 585-588. Methods and equipment employed in turning spherical and irregular shaped work are described. Ha (4d)

When Are Machine Tools Obsolete? H. D. HALL. *American Machinist*, Vol. 78, July 4, 1934, pages 470-473. Conditions and features which make machine tools fail in adaptability, productive capacity or result in too high maintenance cost, and which make replacement advisable, are discussed. Ha (4d)

HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Grain Size in Steel, Some of the Practical Aspects. R. L. WILSON. *Metal Progress*, Vol. 26, Aug. 1934, pages 17-22. Discusses such practical aspects of grain size control as machinability, hardening range and depth, warpage, toughness and heat treatment economies obtainable by single quenches of fine grained carburizing steels. WLC (5)

The Heat Treatment of Cast Iron. CARL H. MORKEN. *Iron Age*, Vol. 132, Sept. 28, 1933, pages 24-27; *Fuels & Furnaces*, Vol. 11, Nov.-Dec. 1933, pages 221-224. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 476. VSP+Ha (5)

The Manufacture of Drill and Other High Grade Steels at Vereeniging, Transvaal. J. H. DOBSON, G. ROBSON, J. BURNARD BULLOCK & H. CLARK. *Journal of the Chemical, Metallurgical & Mining Society of South Africa*, Vol. 34, May 1934, page 384. Discussion. See *Metals & Alloys*, Vol. 5, June 1934, page MA 300. AHE (5)

An Investigation of Equilibrium Diagrams of Salts for Salt-baths. Part IV. The Equilibrium Diagram of $BaCl_2$-$CaCl_2$-NaCl System. TOMO-O SATÔ & TEI-ICHIRÔ AMANO. *Kinzoku no Kenkyu*, Vol. XI, June 20, 1934, pages 305-316. Using 16 kinds of salt mixtures thermal analysis was carried out and the equilibrium diagram of the $BaCl_2$-$CaCl_2$ system was constructed. The melting point of $CaCl_2$ was found to be 777°. In this binary system eutectiferous mixture is formed, and the eutectic point is 54 mol % $CaCl_2$, 617°. The transformation point of $BaCl_2$ at 927° is represented by a horizontal line in this binary system. In solid $CaCl_2$ a small amount of $BaCl_2$ is dissolved. Thermal anlysis was also carried out for 22 and 17 kinds of binary mixtures of salts, $BaCl_2$-NaCl and $CaCl_2$-NaCl respectively, and the equilibrium diagrams of the both systems were constructed. In these binary systems eutectiferous mixtures are formed; the eutectic points are 40 mol % $BaCl_2$, 656° and 54 mol % NaCl, 501°, respectively. In solid NaCl 5-10 mol % $BaCl_2$ is dissolved at the eutectic temperature. In the $CaCl_2$-NaCl system the formation of a compound, $4NaCl.CaCl_2$, which is assumed by Menge could not be proved in the present investigation. A study of the ternary system, $BaCl_2$-$CaCl_2$-NaCl, was made with 52 mixtures, and several isothermal and sectional diagrams as well as a projection diagram of the space model were constructed. In this system, a ternary eutectic is formed at 453°, 16 mol % $BaCl_2$, 47 mol % $CaCl_2$, and 37 mol % NaCl, three monovariant eutectic curves meeting at this point. TS (5)

Proposed Diagrams for Carbon Steels (Diagrammes Proposes pour la Representation des Aciers au Carbone). J. SEIGLE. *Chimie et Industrie*, Vol. 31, Apr. 1934, pages 773-785. The author proposes to develop one of his ideas and to utilize more completely the information in the diagrams of carbon steels, with especial reference to the question of the solubility of cementite, since his point of view is quite different from the usually accepted one. His ideas, he says, are based on experience. He explains in part VI how, according to the transformation, he differs, and wherein the difference lies. MAB (5)

Changes in Form Caused by Heat-Treatment. E. F. LAKE. *Iron & Coal Trades Review*, Vol. 128, May 11, 1934, pages 763, 767. See *Metals & Alloys*, Vol. 5, July 1934, page MA 326. Ha (5)

Heat Treatment of Stressed Hollow Bodies During Welding (Die Wärmebehandlung beim Schweissen spannungsreicher Hohlkörper). JOSEF FEYER. *Der Autogen Schweisser*, Vol. 7, May 1934, pages 67-68. Deals with the heat treatment of castings before, during, and after welding to prevent stress concentrations. Articles are heated by hot air in automatically controlled furnaces. Kz (5)

Heat-Treating in the Small Shop. F. H. COLVIN. *American Machinist*, Vol. 78, Sept. 26, 1934, pages 675-676. Some approved procedures and heat-treatments are described. Ha (5)

Heat Treatment of Large Forgings. *Engineering*, Vol. 137, June 22, 1934, page 713. Forgings supplied to a coal hydrogenation plant measure approximately 35 ft. long by 6 ft. 6 in. Illustration shows heat-treatment furnace. Heat treatment involves oil hardening and tempering. Forging weighs 80 tons, probably largest forging of equal mass ever handled in England. LFM (5)

Annealing (5a)

The Alpha-Gamma Transformation in Steel with Reference to the Dilatometric and Magnetic Effects (La Transformation Alpha-Gamma dans les Aciers Envisages au Point de Vue de Ses Effets Dilatometriques et Magnetiques). J. SEIGLE. *Chimie et Industrie*, Vol. 31, Feb. 1934, pages 282-288. The dilatometric and magnetic tests were made to show only the α-γ transformation of iron which is the chief phenomenon to be used to explain the anomalies which occur. Pearlite forms on cooling and disappears on heating, which is considered to be of much less importance than is usually accorded these changes. The author says that the changes depend entirely upon the proportions of α and γ iron at each moment; they vary according to a geometric rule once the principle has been established. α and γ iron may be free or in the pearlitic state and occur either as magnetic, pure α solid solutions or non-magnetic pure γ solid solutions. The former takes place below the Ac_1 on heating and below the Ar_1 on cooling. The latter occurs above the Ac_3 on heating and above the Ar_3 on cooling. The third form in which they occur is in an α-γ mixed solution which is found between the Ac_1 and the Ac_3 on heating and between the Ar_3 and the Ar_1 on cooling. According to conditions, heating or cooling, the solution (α-γ) changes composition regularly or remains the same for a time during a period in which the temperature is more or less stable. This solution is magnetic and resembles α iron more than γ iron, but that does not depend upon the proportion of composition. The magnetism and the coefficient of expansion of this (α-γ) solution remain constant when its composition remains constant. When mild ordinary steel was heated to 770° (around the Ac_1 point) a magnetic, quickly reversible change was noted. The author thinks it was because the solution could not solidify again only with a smaller per cent of iron in the γ state. This magnetic change corresponds to the Curie point of α iron but it is only brought on then because the α iron requires a little γ iron. MAB (5a)

Bright Annealing of Wire in Electric Furnaces. O. S. HASKELL. *Wire & Wire Products*, Vol. 9, Sept. 1934, pages 304-308. Types of electric furnaces available for successful bright-annealing, advantages over other furnaces, surface conditions of wire, costs, and general operating conditions are discussed. Cu, low and high C-steel, monel meta', brasses and bronzes have been bright annealed with proper furnace atmosphere Tables and heating curves are given. Ha (5a)

Improvement of Physical Properties of Chromium Platings by Heat Treating (Zur Vergütung von Verchromungen durch Wärmebehandlung). WERNER FRÖLICH. *Die Metallbörse*, Vol. 24, May 19, 1934, pages 629-630. Electrolytically deposited Cr contains considerable amounts of H_2 which increase the hardness and decrease the resistance against corrosion. Opinions are still divided whether H is exclusively absorbed or present as a Cr-H alloy or in both forms. Although Cr platings are hardly submitted to bending or similar stresses where the H embrittlement could play an important role, stains often appear after short service times due to the presence of H. There are technical and economic limits to depositing Cr at the lowest possible H evolution, i.e., at low current densities and high bath temperatures or vice versa. Pointing out at length the successful elimination of H in Zn and Cd coatings, test with Cr platings showed that 30 min. at 230°-240° C. completely remove the detrimental H content. Several hours are required for this purpose at 95°-100° C. As is the case with Cd deposits, this heat treatment does not work if intermediary layers have been utilized. The H in the latter causes porosity in the outermost Cr coat. The pores become centers of corrosion attack and thus annul the benefit of a heat treatment. EF (5a)

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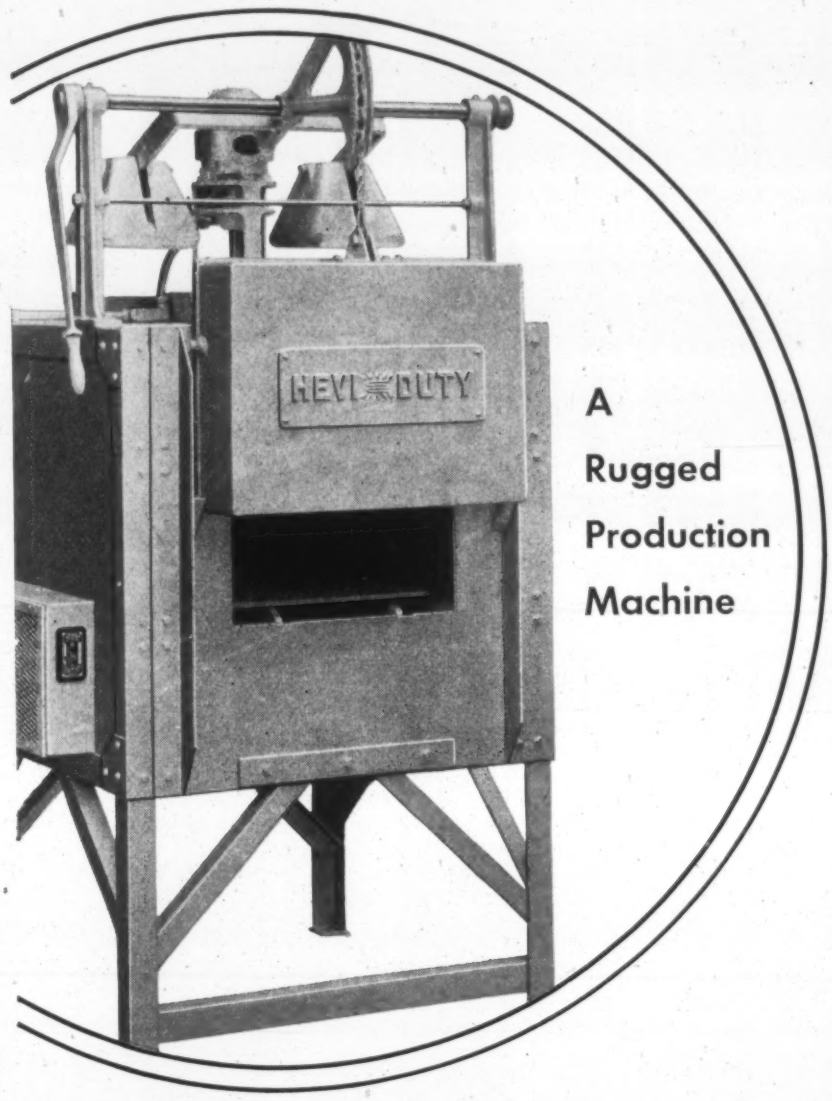

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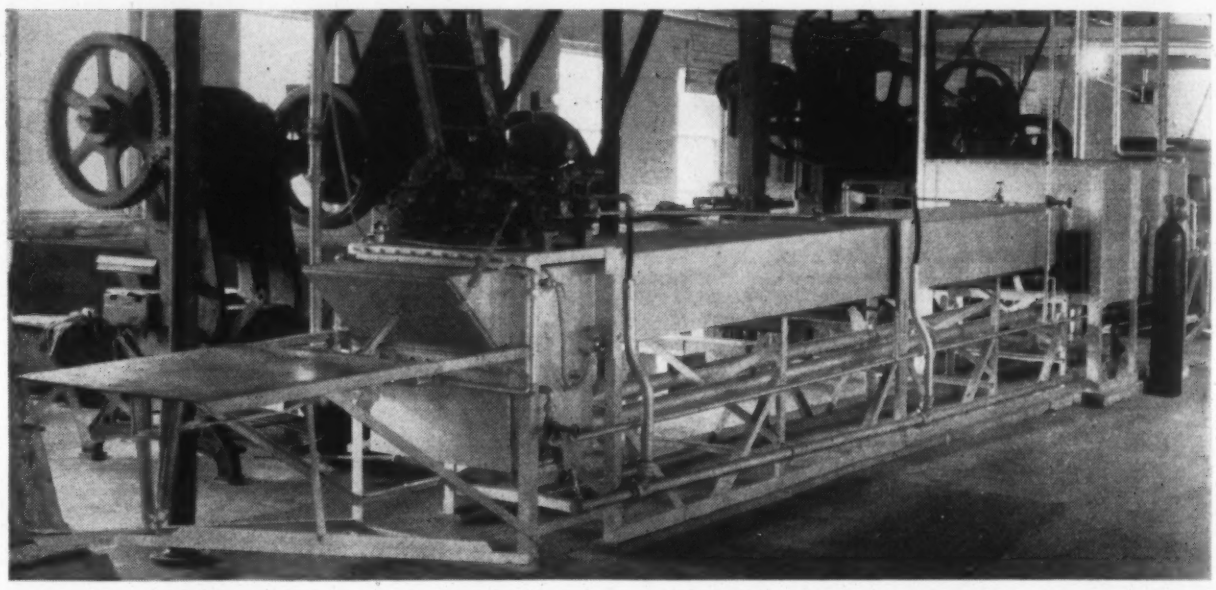


Self-Annealing of Chill-Mold Iron (Auto-Recuit des Fontes trempées sur Coquilles). G. HÉNON. *Usine*, Vol. 43, Aug. 2, 1934, page 27. Self-annealing is called the graphitizing pearlitic annealing of the chilled parts of a piece by the heat stored in the mold the dimensions of which are properly chosen for this purpose. In general, the mass of the chill-mold is a quarter of the mass of the piece to be annealed; the material of the mold is preferably a "refractory" casting, i.e., 3-3.4% C, 1.5% Si, 0.8% Mn, 0.6% Cr, less than 0.08% S, less than 0.3% P for wall thicknesses of 8 to 20 mm.; pouring temperature should be about 1400° C. The iron for self-annealing should have 3-3.4% total C, 0.5-0.8% Mn, 1.3-1.4% Si (which permits a pearlitic structure in pieces of 25-50 mm. wall thickness cast in sand), less than 0.08% S, 0.1-0.5% P. Details of machining operations of hard surfaces are given. Ha (5a)

Hardening, Quenching & Drawing (5b)

Hardness and Depth of Quench of Alloyed Chilled Castings (Ueber die Härte und Schrecktiefe des legierten Schalenhartgusses). E. SCHUEZ. *Giesserei*, Vol. 21, Aug. 3, 1934, pages 321-327. Relations of surface hardness to C content are quite definite in white cast iron but not in gray iron; the curve is linear, to each 0.1% increase of C corresponds an increase of 11.23 Brinell or 1.67 Shore hardness. Attention is called to the important fact that hardness values measured with different apparatus are not directly comparable. The influence of the most used alloying elements on hardness and depth of quench is then discussed on the basis of investigations by Taniguchi. Depth of quench is measured in 3 sections: 1. Clear chilled part, which extends from the surface to where the first gray points occur. 2. Useful chilled part, which extends to the clear gray iron, and 3. Total chilled part, extending to the ends of the white spots in the gray iron. The effect of the elements in the order of influence on hardness is: (strong) Ni, Mn, P, Sn, Cr, Mo, Cu, W, Al, V, Ti, Co, Si, S (weak); C increases hardness most, Ni has a maximum effect at 4.5%, Cr increases hardness very little even in contents up to 24% but serves to regulate the depth of quench. The order of elements with respect to their influence on depth of quench is: graphitizing: (strongly) C, Si, Al, Ti, Ni, Cu, Co, P (weakly); neutral: W; hardening: (weakly) Mn, Mo, Cr, Sn, V, S (strongly). The maximum of hardness with increasing C content, from steel to white cast iron, passes slowly to lower Ni content; e.g., there are maxima for 0.12% C at 20% Ni, for 0.25% C at 12% Ni, 0.80% C at 7% Ni and 3% C at 4.5% Ni. Numerous curves show the test results of the effect on hardness, tensile strength and specific impact energy of the elements and of Cr-Ni alloys of 0-2.3% Cr and 0-6% Ni. The technically best compositions lie between the points 1.2% Cr and 3.3% Ni, 1.6% Cr and 4.3% Ni, 0.2% Cr and 3.9% Ni, and 0.5% Cr and 4.8% Ni. (These alloys are protected by DRP. 577 923, of the Mond Nickel Co., London.) This material is particularly suitable for rolls for cold- or hot-rolling; such rolls have a longer life, 40-50 days at 20 hrs. against one week at 6 hrs. for ordinary hard-cast rolls. They have great hardness and produce, therefore, highly polished sheets. Friction losses in bearings are low owing to the great hardness of the roll necks. Ha (5b)

Hardening Rail Ends. *Railway Engineer*, Vol. 55, July 1934, page 210. Summarizes the process carried out *in situ* by the Chicago, Milwaukee, St. Paul & Pacific Railroad. A hand-welding torch heats the rail ends to a temperature above the recalescence point, followed by pouring a definite quantity of water upon the ends. This leaves the end in a martensitic condition, which is dangerously brittle, but a second heating reduces the hardness to the desired degree. Quenching and subsequent annealing is done away with if the cold metal of the rail body acts as a quenching medium for the rapidly and highly heated (1400°F.) head. The flames of 6 oxy-acetylene burners oscillate through a small arc so that the top surface of the rail is uniformly heated to a depth of 1/8"-3/16" for a period of about 15 sec. Brinell hardness of the rail surface is thus raised by about 100 units. WH (5b)

The Heat Treatment of Carbon Tool Steel. J. C. ALEXANDER. *Mechanical World & Engineering Record*, Vol. 95, June 15, 1934, pages 578-580. C tool steels will always find a place in tool rooms, as they possess properties 6 which alloy tool steels do not, and for many types of tools facilitate fabrication and quick heat treatment. Failures in heat treatment of C steels are more common because insufficient care is taken as far as the following points are concerned. Choice of C content which ranges from 0.60% to 1.40%. There is a C content to suit every purpose and every type of tool. To obtain toughness (pneumatic snaps and chisels, swaging dies, etc.) hypoeutectoid steel (less than 0.89% C) should be chosen, if retention of cutting edge is required (press blanking tools, shear blades, etc.) hypereutectoid steel (more than 0.90% C). It is more difficult to break down globular cementite (spheroidized condition) than laminated cementite (normalized condition) by heat so as to obtain its complete absorption into the Fe, and unless tools are normalized before hardening there is every possibility that some of the cementite will not be absorbed, 7 leaving the tools patchy in hardness and irregular in depth of hardness penetration. To normalize, heat to 800°-815° C. and cool in air. Depth of hardness penetration (maximum: 1/8" to 5/32") is subjected to variation with varying thicknesses of steel. Failures due to different rates of contraction on cooling can be overcome by change in design or by studying the possible effects likely from different quenching positions. Hardening temperature limits are very narrow and have to be strictly observed. It is a good practise to allow the tool to soak for 5-10 min. at its hardening temperature with burners slightly shut down to allow the outside and inside of the tool to become quite uniform and to prevent quenching on a rising temperature. Re-hardening: To proceed from the hardened to the re-hardened state without normalizing is to force the steel 8 through an unnatural cycle of physical changes which prevents its retention of the best physical and mechanical properties. Discussing errors in design it is said that no part of a tool should be thinner than 3/8", which will allow a hardened surface and a soft core, avoid sharp corners, design so that the metal is of even width. Kz (5b)

Hard Facing Cuts Tool and Die Costs. *Oxy-Acetylene Tips*, Vol. 13, July 1934, page 159. Stellited fabricating tools for drum manufacture lasted 4 times longer. Ha (5b)

The Maximilianhütte Martensitic Rail Treatment. CECIL J. ALLEN. *Railway Engineer*, Vol. 55, Aug. 1934, pages 247-249. The novel rail treatment of the Eisenwerkgesellschaft Maximilianshütte, Germany, represents a rapid water quench 9 of the rail head from 820° C. A basic open hearth or Thomas rail steel of a relatively low C content of .36-.42% is utilized. The Mn limits are .8-1.0% and Si 0.1-0.2%. Up to .08% P are allowed. A tensile strength of 38-44.5 ton/in.² is quite sufficient since the maximum axle load in Germany is only 20 tons. Lower C steel yields sufficient strength base and web, lessens the danger of brittleness, and the drastic hardening does not give rise to shatter cracks. Testing data according to the German standards are tabulated referring to 7 different martensitic rails (analyses given) with emphasis on impact tests. Owing to the difficulties of cutting a tensile test bar from the hardened portion of the rail, the tensile strength is determined by Brinell tests. The hardness is 10 not measured on the running surface but 5 mm. below the surface. The hardness distribution over the rail cross section reveals that the hardness in the whole rail head has been raised, gradually approaching double the strength of the untreated web towards the outermost regions of the head for which the German standards demand 130 kg./cm.² strength. The latter is easily met with by the new rail heat treatment. A set of five microstructures taken along the vertical axis of the rail head clearly shows the gradual change from martensite to pearlite from the rail surface to the upper extremity of the web. WH (5b)

Modern Cast Iron Refining Problems (Das neuzeitliche Gusseisenvergütungsproblem). M. v. SCHWARZ & A. VAETH. *Die Giesserei*, Vol. 21, Aug. 17, 1934, pages 245-248. There are at present available 3 classes of refinable cast Fe: 1. air-hardening cast Fe, 2. nitrided cast Fe, and 3. pure refinable cast Fe's with not more than 2% refining elements, e.g. Ni, or Cr, or both. Air-hardening cast Fe's are alloyed with Cr, Ni or Mo to just such extent that no white solidification takes place. Nitride cast Fe contains also refining additions. The principle of refining lies in creating a wear-resisting structure on the surface which not only must possess a certain hardness but also work well together with the material against which it is moving. Tests with unalloyed and low-alloy cast Fe's showed that the required quenching temperature increases with increasing P content at about the same Si content. Cast Fe's up to 1.5% P can be hardened and tempered and show the familiar hardening and temper structures. Ni reduces the required minimum quenching temperature; an Fe with only 1% Ni has a very hard, stable martensite layer which transforms, during tempering, very slowly into a granular pearlite structure. Formation of eutectic graphite promotes the decomposition of hardening and tempering structure; refinable Fe's must, therefore, not contain eutectic graphite. 18 references. Ha (5b)

Studies on Hardening and Tempering Temps. for High Speed Steel. KAZUO MORIDERA. *Seitetsu Kenkyu*, No. 137, May 31, 1934, pages 21-26. 5 kinds of high speed steel (0.75-0.92% C, 4.04-4.54% Cr, 16.83-19.93% W, 0-1.64% Mo, 1.24-1.53% V, 4.26-9.94% Co) were heated at various temps. between 1,000°-1300° C. after being preheated at 900°, preventing oxidation and decarburization with charcoal powder, and then quenched in seed oil. The hardened specimens were tempered at various temps. between 100°-700° C., and Shore's hardness of them were tested. In quenched state, the steels quenched at 1150°-1200° C. show the max. hardness, excepting the high Co, W and high Mo, Co steels, in which the max. hardness was obtained by quenching at 1300° C. Generally, the increase of hardness by tempering was not observable in the steels quenched at a temperature below 1250° C. Proper quenching temperature of high speed steel was determined to be 1250°-1300° C. The max. value of red hardness was obtained by tempering at 550°-600° C. High speed steel treated at the proper conditions of quenching and tempering shows more than 100 in Shore's hardness number. Low Co high speed steel treated properly shows nearly equal hardness to high Co one. The effect of Mo and V on the hardness of high speed steel was not detected. TS (5b)

On the Hardness Change of High Chromium Steels due to Heat Treatment. YOSITUGU MISAWA. *Kinzoku no Kenkyu*, Vol. XI, June 20, 1934, pages 283-304. The transformation points of A_1, A_3 and A_2 of 20 kinds of high Cr-steels containing about 14, 18, 22 and 26% Cr with varying C content less than 0.7% were determined by dilatometric measurement and magnetic analysis. The hardness of specimens which were annealed, quenched in oil at 900°-1200° and tempered at 200°-700° was measured by Rockwell hardness tester. The effect of C and Cr contents, and of quenching and tempering temperatures on the hardness of these steels was studied. The change of the microstructure due to the above heat treatment was also examined. The result obtained is summarized as follows: In 14 and 18% Cr steels, A_1 point rises as C content increases on slow heating and cooling. A_3 point in the former steels falls as C content increases while in the latter it does not appear. In 22% Cr steels, A_1 transformation does not take place at the temperature below 1000°, and in 26% Cr steels, both A_1 and A_3 transformations do not take place. The A_2 point always rises as C content increases. Hardness of 14% Cr steels quenched at the temperatures below 1000° rises as C content increases while it shows a maximum at 0.45% C for the specimens quenched at the temperatures above 1100°. Hardness of 18, 22 and 26% Cr steels quenched at various temperatures above stated rises with C contents. The 14% Cr steels quenched at 900° shows a maximum hardness at 400° on tempering, and those quenched at 1200° shows the maximum at 500°-600° excepting that containing 0.07% C. In 14% Cr steels the hardness of the quenched specimens is higher than that of tempered excepting high C steels. Change of hardness of 18% Cr steels quenched at 900° due to tempering is not remarkable, while hardness of those quenched at 1200° rises by tempering at 600°. In 22 and 26% Cr steels, the change of hardness due to quenching and tempering was not found. TS (5b)

Quenching Steel in Hot Lead. T. P. HUGHES & R. L. DOWDELL. *Transactions American Society for Metals*, Vol. 22, Aug. 1934, pages 737-750. Data are presented showing that approximately the same mechanical properties are obtained in C steels, 0.34 and 0.49% C. on quenching in lead at 600° F. as those obtained by oil quench and draw at 1200° F. The data also show the variation in properties with changes in quenching temperature and temperature of the lead. 25 references. WLC (5b)

Surface Hardening (Aus der Praxis der Oberflächenhärtung). GREGER. *Der Autogen Schweisser*, Vol. 7, June 1934, pages 83-84. Discussion of the surface hardening of worn machine parts which have been repaired by means of build-up welding. The C steel used for the build-up job contains 0.4-0.7% C. Hardening is carried out by heating with the oxy-acetylene flame and quenching in water. KZ (5b)

Aging (5c)

An Analogy Between Plastic Deformation and Certain Cooling Rates in Causing "Premature" Precipitation in Supersaturated Solid Solutions—The Incubation Period—Part I. J. L. BURNS. *Transactions American Society for Metals*, Vol. 22, Aug. 1934, pages 728-736. It was found that plastic deformation of a solid solution immediately after quenching results in quicker aging without the incubation period and the final hardening is less. If a particular rate of cooling in the quench is employed the same result occurs from which it is concluded that plastic deformation does not increase rate of hardening but merely causes it to start earlier. WLC (5c)

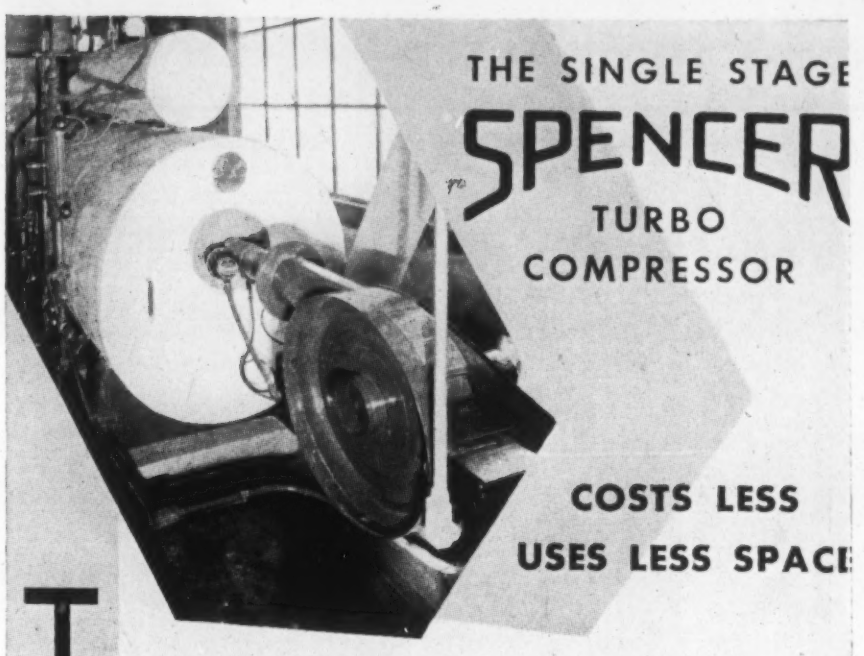
Malleableizing (5d)

The Determination of the Rates of Graphization at 925 Degrees Cent. in Tungsten-Manganese White Cast Iron. W. A. PENNINGTON & W. H. JENNINGS. *Transactions American Society for Metals*, Vol. 22, Aug. 1934, pages 751-768. Mn and W are found to favor the formation of carbides in white iron. Mn up to 1% in the absence of FeS has little effect upon the first state of graphitization. As Mn increases from 1% the time of graphitization increases to a maximum at about 3% Mn, then decreases gradually from 3-5%. W up to 5% in presence of 1% Mn slightly retards graphitization but it accelerates graphitization in presence of 2.5% Mn. WLC (5d)

The Occurrences of Crystallization in Malleable Cast Iron During Freezing and Malleableizing (Die Kristallizationsvorgänge bei Temperguss bei der Erstarrung und beim Glühprozess in gemeinfasslicher Darstellung). OTTO BRAUER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, May 27, 1934, pages 219-221, July 22, 1934, pages 304-306. Author discusses the occurrences on the basis of the Fe-C diagram and outlines the theory of malleableizing. GN (5d)

Carburizing (5e)

Grain Size and Grain Growth. M. A. GROSSMAN. *Transactions American Society for Steel Treating*, Vol. 21, Dec. 1933, pages 1079-1111. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 476. WLC (5e)



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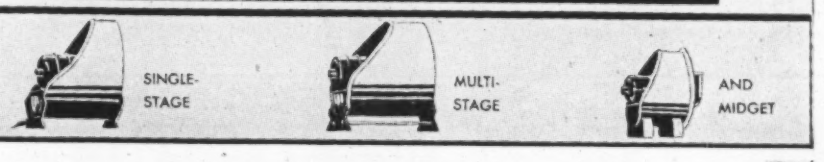

Contribution to the Study of Cementite (Contribution à l'étude de la cémentite). PIERRE PINGAULT. *Annales de chimie*, Vol. 20, Nov. 1933, pages 371-438. Methods previously applied for preparation of cementite are reviewed. Pingault utilized alkaline cyanides, methane, illuminating gas, and carbon monoxide. NaCN (99% pure) reacted upon electrolytic Fe powder (.003 C, .005 Si, .002 S, .009 P, trace Mn) in an Fe crucible placed into a resistance furnace. The Fe_3C preparation contained 6.65-6.70% C (.05% graphitic C). The appearance of the cementite obtained and the carburization speed are discussed. NaCN readily oxidized, but exclusion of air yielded less favorable results. The presence of O_2 seems to be prerequisitive to this carburization process. An electric current between 2 soft Fe electrodes in NaCN did not affect the carburization process but the anode was hardened due to carburization. H_2 under atmospheric pressure also did not exert an influence on Fe_3C at 450°C. The carburization of various ferrous materials was studied. Gray cast Fe (total C=3.22, graphite=2.55. Si=1.86, Mn=1.15, S and P=.09) was not uniformly carburized after being held at 650°C. for 24 hrs. while small Fe blocks were completely carburized after 500 hours and contained 6.65% C but no graphite. Soft steel wire (2 mm. diameter) was case-hardened in NaCN after 1.5 hrs. when exposed to temperatures of over 900°C. More Fe_3C formed on further heating. It was established that Cr and Ni do not affect the carburization of steel. Utilization of methane and purified city gas also yielded favorable carburization results. A 6 mm. soft steel rod and a soft steel wire were successfully carburized, the latter in 8 hrs. at 850°C. The action of CH_4 is the same as illuminating gas. A special chapter is devoted to the action of CO. The physical properties of cementite are studied. Density=7.43, 7.003 (electrolytically prepared) and 7.3 (same except reduced with H_2). Hardness tests with standard methods are difficult to accomplish. Fe_3C scratches glass. Exposed to 1000°C. for 1 hr. no changes were noticed, but after 8-10 hrs. exposure graphite is set free. This becomes more pronounced at 1175°C. Samples exposed to 1225°C. (1 hr.) yielded globules resembling cast Fe rich in C and a powder high in graphite (HNO_3 test). There seems to be no transformation of Fe_3C between 500° and 1000°C. Above the latter temperature testing difficulties arise due to the beginning decomposition of Fe_3C. The fourth chapter deals at length with equilibria conditions in the Fe-Fe_3C-O system. The gas atmosphere (CO, CO_2) circulated and piano (.8% C) and soft steel wire (.09%C) were used. CO_2/temperature curves are presented for the principal reactions (1) $2\ CO=CO_2+C$ and (2) $2\ CO+3\ Fe=CO_2+Fe_3C$. Test data on carburization and decarburization between 820° and 1000°C. are tabulated. The last chapter reports on attempts at carburization of Mn and Cr. A protective layer of Cr carbide quickly stops further carburization. The original C content of .4% could only be raised to .68%. With Cr powder, the C content was .8%. Cyanide carburization of Mn failed. CH_4 carburizes Mn at moderately high temperatures. WH (5e)

Nitriding (5f)

Nitrides Cast Iron Cylinder Liners. F. GIOLITTI. *Metal Progress*, Vol. 24, Sept. 1933, page 45. The writer describes the application of cast iron of total C 2.40%-2.80%, Si 2.40%-2.80%, Mn 0.50%-0.70%, Cr 1.30%-1.70%, Al 0.60%-0.80% with S and P less than 0.07% as cylinders and cylinder liners in motors and pumps hardened by nitriding. Nitriding practice is described, hardness and service results given. WLC (5f)

Nitriding Process. JOHN DUMMELOW. *Electrician*, Vol. 112, Mar. 9, 1934, pages 333-335. The nitriding of alloy steels and cast-iron parts is outlined. Discussion follows on the equipment used, the necessity of temperature control, physical properties of the nitrided surfaces, and the advantages of surface hardening by nitriding. CBJ (5f)

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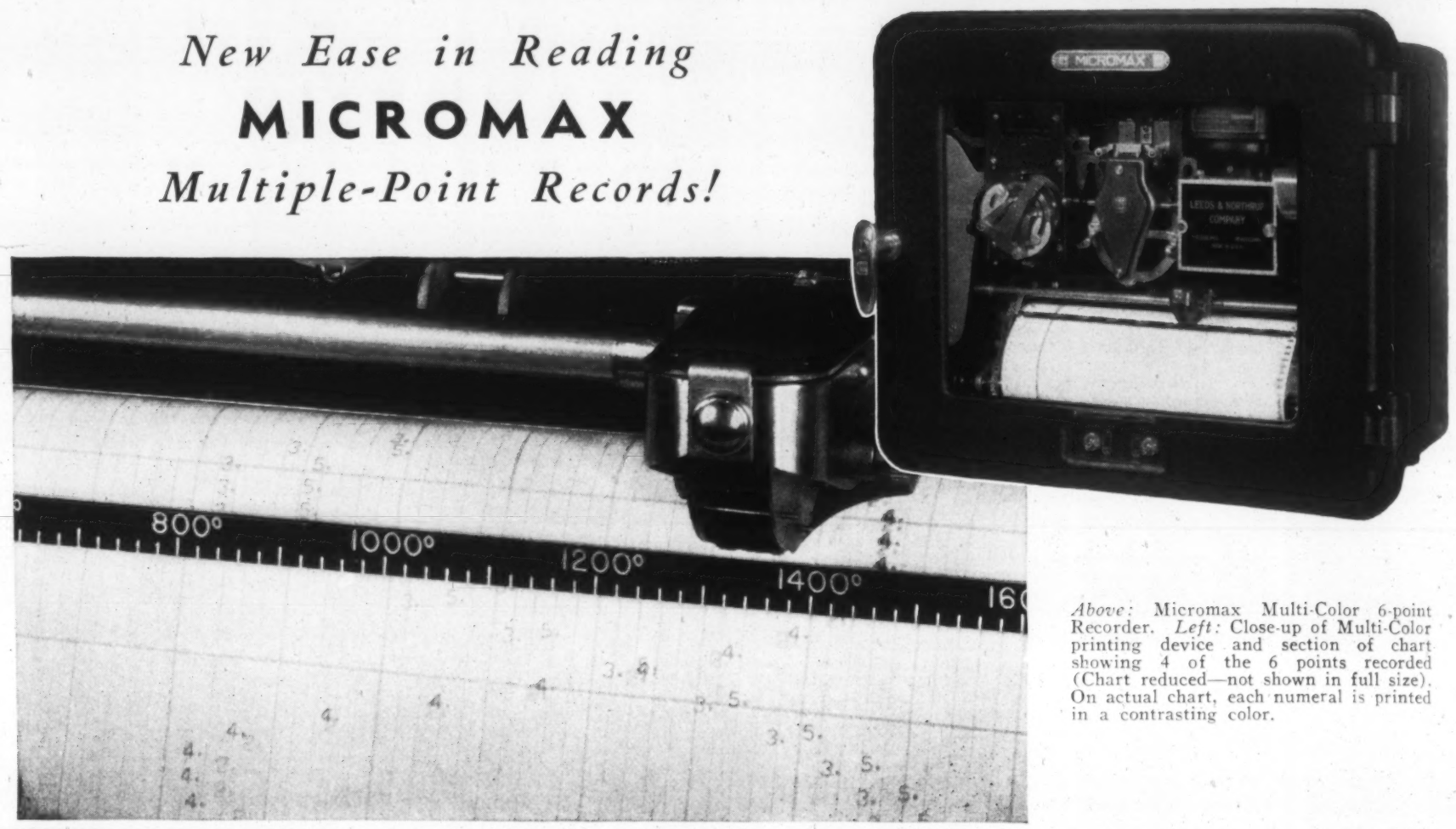

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FURNACES, REFRACTORIES & FUELS (6)

M. H. MAWHINNEY, SECTION EDITOR

Highly Refractory Si-C Material (Hochfeuerfestes Si-C Material). C. RÜHL. *Die Wärme*, Vol. 57, June 23, 1934, pages 407-408. See "Highly Refractory Silicon Carbide Bricks for Boiler and Industrial Furnaces," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 399. EF (6)

The Electric Melting and Heat Treatment of Iron and Steel. A. G. ROBIETTE. *Journal West of Scotland Iron & Steel Institute*, Vol. 41, Dec. 1933, pages 41-49, discussion 49. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 478. GTM (6)

Modern Methods of Heat Insulation. CYRIL S. WOODWARD. *Transactions Ceramic Society*, Vol. 38, Feb. 1934, pages 73-82. In the range 212° to 600° F. the most widely used of all insulating material is magnesia, which is made up in the form of slabs and sections and also as a powder known as "plastic." In this form it is rendered down with water and applied in layers in the form of plastic. Composition by weight consists of 85% hydrated magnesium carbonate, with addition of 15% asbestos fibre to form a binder. At 600° F. disintegration of this material commences. For temperature of 1000° F. and over insulating brick having a diatomaceous base are used. GTM(6)

Electric Hardening Furnace for High-Speed Steel (Elektrischer Schnellstahlhärteofen). H. DICKS. *Elektrowärme*, Vol. 4, Aug. 1934, pages 186-187. See "Furnaces for High Temperatures, Especially for Ceramic Purposes, Melting and Forging," *Metals & Alloys*, Vol. 5, June 1934, page MA 260. Ha (6)

Pipe Furnaces at National Tube. J. B. NEALEY. *Heat Treating & Forging*. Vol. 20, July 1934, pages 353-354. See "Natural Gas Furnaces in Steel Tube Making," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 478. MS (6)

Tilting Induction Furnace in Steel Works Working on Three Phase Current (Four à industion d'aciéries oscillant, alimenté en courant triphasé). *Genie Civil*, Apr. 1934, page 342. Abstract of Hessenbruch & Rohn paper in Stahl und Eisen, Jan. 25, 1934. See "Low Frequency Coreless Induction Furnace," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 387. JDG (6)

Special Refractories for Metallurgical Research at High Temperatures. DONALD TURNER. *Transactions Ceramic Society*, Vol. 33, Feb. 1934, pages 33-52, discussion pages 52-55. Deals mainly with a number of refractories developed to satisfy the requirements of a series of researches on alloys of iron. Refractory crucibles for temperatures above 1600°C. were required. Siliceous materials in contact with molten metals at high temp. are reduced by H_2, and since the final purification of iron, Cr, and other metals involves the removal of traces of oxide present in the metal by the treatment of the molten metal with hydrogen, the presence of silica in the refractory container invariably results in the introduction of Si in the metal. With the possible exception of a few substances such as the nitrides of Boron or Mg, the selection of refractory for this purpose is limited almost entirely to one of the refractory oxides such as: Al_2O_3, MgO, Thoria, Berylla, Zirconia, and CaO. Preparation of these materials in the form of crucibles presents considerable difficulty. Pure Al_2O_3 crucibles are excellent for use under reducing condition. This material is converted into an extremely hard, dense and translucent body but not extremely resistant to corrosion. Pure MgO, Al_2O_3, and Thoria crucibles all show considerable resistance to corrosive action of metals at high temp., even under reducing conditions. GTM (6)

Economics of Electric Resistor Furnace Design and Construction in Japan. JAMES A. RABBITT. *The Far Eastern Review*, Vol. 30, Feb. 1934, pages 80-85; Mar. 1934, pages 135-143. Suggestions are furnished for methods of insulation and wiring with the most efficient alloys for resistor elements in electric resistor furnaces. The paper exhaustively discusses the advantages of electric heating, economy of electric resistor furnaces, loss through openings, heat loss through walls, thickness of insulation, method of determining rate of conduction through walls, surface resistance, calculation for temperature gradient, heat conductivity of materials, malleable and cast resistance alloys for electric furnaces (3 tables with 80 complete chemical analyses and manufacturer given), range of furnaces, selection of kind of resistor, selection of resistor, resistor calculations, comparison between life and price of 2 resistance wires. WH (6)

Enriched Air for Open-Hearth Furnaces. B. M. SUSLOV. *Metal Progress*, Vol. 26, Sept. 1934, pages 40-41. Two tests are described of the use of O_2 enriched air in open-hearth operations with tentative conclusion. Product normal, combustion conditions improved and flame temperature raised, time decreased, refractories do not suffer appreciably. May affect working of heat as to pig, ore and alloy additions, materially change practice and time, and increase fuel consumption. WLC (6)

An Electric Melting Furnace for Non-Ferrous Metal Foundries (Ein Elektroschmelzofen für Metallgiessereien). U. SCHWEDLER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 29, 1934, page 478. Brief description of the rotating arc furnace, system Russ. GN (6)

On the Fundamental Equation for the Design of Electric Resistance Furnaces. MIKIO MUKAIYAMA. *Journal of the Institute of Electrical Engineers of Japan*, Vol. 53, Oct. 1933, pages 881-888. In Japanese. Abstract Section, page 86. In English. Based on practical experiments, the author arrived at the following "design formula for the electric resistance furnace": $y = a\,x^{0.41}$, wherein y = watts, $a = 0.00017\ T^{1.55}$, x = volume of furnace in cm.³, and T = °C. The applicability of the formula has been verified by using in designing 2 electrical resistance furnaces of commercial size. WH (6)

Electric Heating made Economical by Induction Heating (Elektrowärme wirtschaftlich durch Induktionsbeizung). O. NEISS. *Elektrowärme*, Vol. 4, July 1934, pages 154-156. After a brief explanation of the principle of electric heating by induction a few examples are given to show that good economy can be obtained, for instance by heating liquid flowing through pipes, either alone, or in combination with steam heating, in order to utilize a better tariff for electric energy; method of calculating the eventual advantage of this over other heating system is described. Ha (6)

Losses at Joints in Pipe Lines and Mains (Ueber Stossverluste und Wiederstandsbeiwerte in Rohrleitungen und Kanälen). H. EULER. *Archiv für das Eisenhüttenwesen*, Vol. 7, May 1934, pages 606-614. Sample calculations are described in detail for determining the pressure losses at various types of joints in open-hearth furnace gas lines. SE (6)

Rapid Gain in Use of High-Frequency Electric Furnaces. EDWIN F. CONE. *Steel*, Vol. 95, July 23, 1934, pages 46-48. At present, of the 94 high-frequency furnaces operating commercially in the United States, 46 are for ferrous metals, 36 for non-ferrous metals, and 12 for experimental and miscellaneous uses. Total capacity in kw. is 11,145. Size ranges from 17 lbs. to 4 tons. There are 6 in Canada, totaling 550 kw. About 30,000 kw. are installed abroad. MS (6)

Short-Circuiting of Aluminum Furnaces (Kortslutning for aluminiumovner) *Teknisk Ukeblad*, Vol. 81, July 19, 1934, page 363. A new type of switch used for aluminum furnaces with currents above 25,000 amp., in which the current is carried through a set of graphite contacts for a few seconds during opening and closing of the knife switch, thus saving the metal surfaces from damaging arcs. BHS (6)

CRYSTOLON REFRACTORIES

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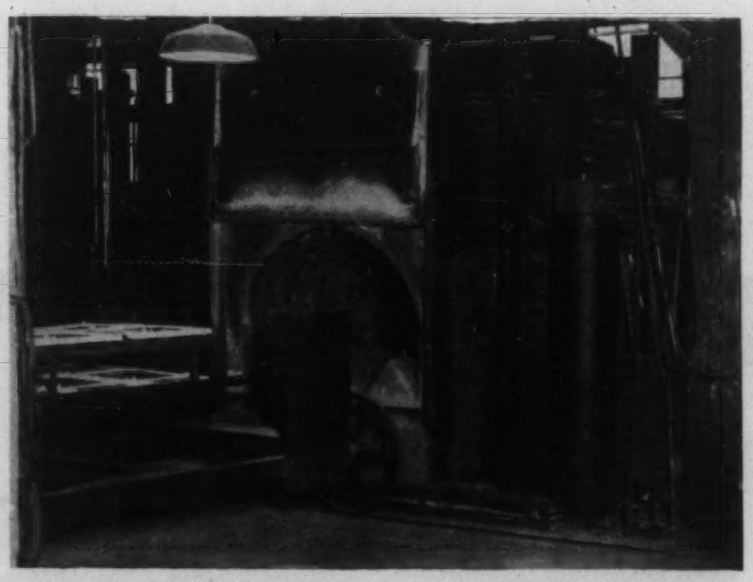

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Electric Furnace (Le Four electrique). MARCEL GUEDRAS. *Métaux* (formerly *Aciers Speciaux, Métaux et Alliages*), Vol. 9, Feb. 1934, pages 47-61, 74. A lecture on general description and discussion of electric furnace and steel making in electric furnace. GTM (6)

1 **Cupola Linings.** J. C. GREEN. *Foundry Trade Journal*, Vol. 50, Feb. 8, 1934, page 102. See *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 401. OWE (6)

Continuous Furnace for Strip and Wire (Der Durchziehofen für Band und Draht). R. GRAENZER & L. MOENNICH. *Elektrowärme*, Vol. 4, Aug. 1934, pages 181-184. Principles of calculation and tables of production for a given width of strip and diam. of wire and a given length of furnace are given. Ha (6)

The Electric Conduction of Three Phase Arc Furnace (La conduite électrique des fours triphasés à arcs). P. GOURDON. *Métaux* (formerly *Aciers Speciaux Métaux et Alliages*), Vol. 9, Apr. 1934, pages 115-124: Operating graphs have been developed such as to enable a constant operating condition of furnace under different circumstances. GTM (6)

The Use of Town Gas in the Steel Industry. H. ALEX FELLS. *Gas Engineer*, Vol. 59, June 1934, Institution Special Number, pages 340-347. Paper before the 71st Annual Meeting of the Institution of Gas Engineers, London, June 5-8, 1934, discusses the "diffusion flame system," a closely controlled combustion, incomplete in the first instance and completed finally at a point in the furnace where surface damage to steel is at a minimum. Gas and air flow along the length of the furnace in parallel streams, combustion taking place at their lines of junction. The highly luminous belt of flame yields a better heat transmission due to its greater radiating power. The danger of burning or overheating the steel is largely minimized. At the hottest end, the furnace hearth is covered with a "belt of unburned gas" to counteract scale formation. The free air tends to remain along the top of the furnace arch. Refractory or heat resisting steel muffles purged with raw gas give excellent results in safety razor blade and small diameter wire manufacture. Bright annealing or heat treatment of stainless steel strip has been done successfully in continuous furnaces using "cooled products of combustion with the addition of suitable amounts of unburned gas." Cracked NH_3 partially burned and the water vapor condensed or chemically removed is suitable for bright annealing or hardening of mild steels and Ni-silver. Methanol vapor diluted with dry products of combustion is used successfully for bright heating of brasses. Steam is similarly suitable for the heat treatment of Cu. The 15 illustrations included show some British gas-fired furnaces and the effect of various furnace atmospheres upon high-speed and low and medium carbon steels exposed to the same temperatures. WH (6)

Nitrogen in Decarburization. B. M. THOMPSON. *Gas Engineer*, Vol. 59, July 1934, page 392. Written discussion to paper of Fells (See abstract above). Author disagrees with the speaker and with Schultz Hülsbruck that pure N_2 does not decarburize steel particularly between 750° and 900°C. Thompson & Gray proved this phenomenon microscopically and by chemical analysis. A low C material could be carburized at the expense of a high C steel placed into the same chamber filled with pure N_2. WH (6)

Gas for Heating Rolls in Sheet and Tinplate Mills. The Phenomenon of Surface Films. A. J. CRUISE. *Gas Engineer*, Vol. 55, May 1934, pages 255-257. Paper before the South Wales and Monmouthshire Gas Salesmen's Circle discusses the sheet makers' problem in regard to heating of the rolls to a definite temperature prerequisite for the production of sheets of a definite finish and standard thickness. The troubles associated with oil firing are a fairly high percentage of cracked rolls due to uneven and excessive heating and the formation of C deposits on the ground surfaces. Oil heating has been superseded by the electrical induction heater which produces eddy currents inside the core (chill cast rolls) but often results in cracking due to over-heating of the internal portions. Gas heating offers a remedy at economic cost and high thermal efficiency. The former gas heating devices are discussed critically. The recent introduction of high pressure gas burners firing into a trough of fire bricks proved to be highly satisfactory. The bulk of the heat transmitted is by radiation from the incandescent refractory and the convection currents in a high degree of turbulence are led around the rotating rolls under a loose asbestos blanket. WH (6)

Vacuum Melting on a Large Scale. HANS DIERGARTEN. *Metal Progress*, Vol. 26, Sept. 1934, pages 43-44. Difficulties in vacuum melting are in maintaining sufficient vacuum in so large an apparatus as production melting furnace, pouring without breaking vacuum, and in finding suitable lining materials. The size of furnaces used for vacuum melting is increasing with 4½ ton furnaces now in operation. WLC (6)

Refractories. D. DIXON. *Steam Engineer*, Vol. 3, Jan. 1934, pages 149-150; Feb. 1934, pages 204-206. General. AHE (6)

Iron Block Heat Storage Furnace With Wide Controlability (Eisenblock-Speicherofen mit grosser Regelfähigkeit). G. DETTMAR. *Elektrowärme*, Vol. 4, Aug. 1934, pages 176-181. A new principle for heating rooms, drying chambers, etc., is described. The furnace consists of a heating element built into a round iron block half of which is heat-insulated, and an outer hollow storage body filled with sand. Between the two, a rotatable part is arranged which is made up half of a good heat conductor, half of a good heat insulator. According to the position of this rotating part, more or less heat is transmitted from the heating element to the storage body which also contains adjustable channels for heating the air. This type of furnace is said to be very efficient, economic, flame- and explosion-proof, and hygienic as no external part is hot enough to burn the dust in the air. Ha (6)

The Use of Rich Gases in Combination with Lean Gases for Heating Large Furnaces (L'emploi des gaz riches en mélange avec des gas pauvres pour le chauffage des grands fours). EMILIO DAMOUR. *Revue de Métallurgie*, Vol. 31, June 1934, pages 266-269. Calculations show that the admixture of coke oven or city gas with the lean generator or blast furnace gases increases the value of the calories contained in them rendering their efficiency much greater than is indicated by their calorific value. This addition increases the production of the furnaces. JDG (6)

Semi-Carburization of Coal in France and Germany (La technique de la semi-carbonisation de la houille en France et en Allemagne). CH. BERTHELOT. *Génie Civil*, Vol. 104, June 1934, pages 486-489. Comments on the paper by Koppers in the *Journal of the Institute of Fuel*, London, 1933. JDG (6)

Electric Steel Hardening Furnaces (Elektrischer Schnellstahlhärteofen) *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 1, 1934, page 412. Description of the Junkers steel hardening furnaces distinguished by a special arrangement of the electric resistance heating elements. According to the temperature desired these heating elements are made of Cr- Ni steel, Cr- Ni alloys, or the recently developed high temperature service alloys Megapyr or Kanthal. These furnaces can also be provided with the Birlec-Hayes type "certain curtain" atmosphere control. GN (6)

Pulverised-Fuel Melting Furnace. *Mechanical World & Engineering Record*, Vol. 95, June 15, 1934, pages 573-574. The revolving furnace described and illustrated is designed for use with anthracite coal as fuel the short flame of which allows of combustion being completed before the charge is reached, thereby avoiding contamination of the metal. The furnace features a special form of burner and a high degree of preheating of the combustion air. Melting time and fuel consumption are dealt with. Kr (6)

Atmosphere Control in High-Speed Steel Furnaces. *Machinery*, London, Vol. 44, May 24, 1934, pages 214-215. Deals with the method of atmosphere control developed by the Sheffield Gas Co., England, to prevent scaling and decarburization at any working temperature up to 1385°C. Kz (6)

Some New Improvements of the Electric Furnaces in the Steel Mills of the United States (Quelques récents perféctionnements dans les fours électriques d'acieries aux Etats Units). *Journal du Four Electrique*, Vol. 43, July 1934, pages 244-246. Description of Lectromelt arc furnace with the swinging roof and basket charging. JDG (6)

Investigation on Silicon Carbide Resistance Materials in Air (Untersuchung über siliziumkarbidhaltige Heizleiter in freier Luft). L. Nawo & Wilhelm Meyer. *Elektrisitätswirtschaft*, Vol. 33, July 15, 1934, pages 274-275. Practically the same surface temperatures were measured on resistance bars of silit, globar and quarzilit at the same electrical load over the temperature range of from 800°-1400°C. Inhomogeneities within the resistance materials cause marked temperature gradients. A temperature gradient of 100°C. was found between the surface and inside temperature of a 20 mm. bar at 1500°C. Resistance increases in the testing materials are ascribed to atmospheric O_2 and inhomogeneities in the material itself resulting in uneven temperature distributions. WH (6)

Theory of Regulation of Industrial Electric Furnaces (Theorie des Regelvorganges elektrischer Industrieöfen). Max Lang. *Elektrowärme*, Vol. 4, Sept. 1934, pages 201-208. The principles of calculation of temperature control as determined by the prevailing practical operating conditions are developed and application of the derived formulas illustrated by a few examples. Ha (6)

Use of High Frequency Furnace in Laboratory (L'emploi du four a haute fréquence au laboratoire). G. Kroll. *Métaux* (formerly *Aciers Speciaux Métaux & Alliages*), Vol. 9, Jan. 1934, pages 24-30. General discussion of high frequency furnaces of generator type (Lorenz) and of the condenser type (Ribaud). Lorenz type furnace functions on a power supply of 100-200 volts and 8000 cycles, while the Ribaud type works from a supply of 8000 volts and at 60,000 cycles. The Rohn method of fritting refractory lining used in high frequency furnace is also mentioned. From metallurgical point of view these two types of furnaces are entirely different from each other. Lorenz furnace is preferably used for iron and steel and alloys when the metal is in large sizes, while Ribaud furnace is used for melting granular or powder size materials. Silicon which has been previously heated can be melted in Ribaud furnace because the coefficient of electric conductivity of Si changes at elevated temperatures, but it is not possible to melt Si in Lorenz furnace. Be can be melted in either type furnace. Cu in compact form can be easily melted in the Lorenz furnace due to the very great intensity of the current, but not in Ribaud furnace. GTM (6)

Electric Heat in Chemical and Metallurgical Industry (Elektrowärme in der chemischen und metallurgischen Industrie). H. Kirchrath. *Chemiker-Zeitung*, Vol. 58, May 9, 1934, pages 381-383. Metallurgical applications of electric furnaces are described, for annealing between cold rolling and wire drawing operations. Sometimes neutral or reducing atmospheres are used. Electric furnaces are also used for melting Al, Mg alloys and other metals. CEM (6)

Heat Transfer Rates in Fuel Fired Furnaces. M. H. Mawhinney. *Transactions American Society for Metals*, Vol. 22, Aug. 1934, pages 673-690. Data on 32 furnaces are assembled covering various sizes and shapes of charges, various types and sizes of furnaces for various heat treatments over a considerable range of temperatures. Overall coefficients are calculated and related to rate of heating, furnace size, and character of the work. Relation between weight and surface area. A table gives temperature heads allowable for various heat treatments as found in the author's experience. From these data several specimen examples of furnace requirements are calculated. With discussion. Paper presented before joint meeting A. S. M. E. and A. S. M., New York, Dec. 5, 1933. WLC (6)

Electric Furnaces for Shops (Elektroöfen für Werkstätten). P. Martell. *Die Wärme, Zeitschrift für Dampfkessel & Maschinenbetrieb*, Vol. 57, June 23, 1934, pages 405-407. The advantages of electric heating of industrial (metallurgical) furnaces in comparison with fuel firing are pointed out and the electric furnace types suited for smaller and medium sized shops are classified and discussed under the following viewpoints: electric furnaces with maximum service temperatures of (1) 1000°C., (2) 500°C., (3) above 1000°C., and (4) salt, metal and oil baths electrically heated. EF (6)

Electrically Heated Fine Wire Tinning Furnaces (Elektrisch beheizte Feindrahtverzinnungsöfen). G. Hilgenstock. *Elektrowärme*, Vol. 4, Aug. 1934, pages 174-176. After some preliminary tests, 2 furnaces for 50 and 75 kg. wire per hr. were built holding 125 and 156 kg. molten Sn resp.; the consumption was 3.7 and 5.4 kwhr. resp. and 7.4 and 7.2 kwhr. per 100 kg. wire resp. The bath temperature is 320°C. Cu wire of 0.2-0.5 mm. diam. is tinned. Construction details are described. Advantages claimed: better uniformity of temperature than with any other heating system, which prevents formation of Sn crystals and yellowing of the tinned wire due to overheating; no smoke; automatic control gives independence of operator; elimination of coal and ash transport. An electrically heated furnace can have smaller dimensions than a coal-heated one which also results in greater economy. Ha (6)

New Electric Resistance Furnaces for Very High Temperatures (3000°C). (Nouveaux fours électriques à résistances à très haute température (3000°C). Henri George. *Journal du Four Electrique*, Vol. 43, July 1934, pages 247-252. The furnace consists of an air tight horizontal cylindrical shell with a refractory lining. Along its axis is located a single carbon resistance unit in the shape of a rod properly connected with water cooled contacts on both sides. Several years experience showed that the resistance of this type lasts longer than expected and the carbon consumption is about one third of the electrode consumption of the furnace of the same capacity but of the arc type. Magnesia can be melted in it without difficulties. A furnace of 100 kg. capacity melting bronze operated at 32 volts and 2300-2500 amperes using 0.26-0.33 KWH/kilogram melted, with an average melting time 21-25 minutes. Melting cast iron increased melting time to 36-44 minutes and KWH consumption to 0.58-0.65 per kg. Current density can vary between 100 and 500 amps./cm². Detailed description of the structural features is given. JDG (6)

Electric Radiation Furnaces with Carbon Resistances and Their Application to Melting of Metals (Fours électriques à Rayonnement à Résistance de Carbone et leur Application à la Fusion des Métaux). Henri George. *Révue Générale de l'Electricité*, Vol. 35, June 23, 1934, pages 851-856. The metal is melted in this type of furnace by the radiation of an electrically heated carbon or graphite resistance in the center of the furnace drum. Mn has been melted in such a furnace (2700°C.). Current density in the graphite resistance is about 500 amp./cm.² energy consumption for the production of Si ingots at 2000° C. of 25 cm. diam. and 1 m. length (weight 20 kg.) was 270 KW, melting time 6½ min. starting from cold. Construction and operating details are described. Ha (6)

Should Electric Arc Furnace be Acid or Basic? (Le four électrique à arc doit-il être acide ou basique?) M. Guedras. *Journal du Four Electrique*, Vol. 43, July 1934, pages 242-243. Basic lining permits the use of any kind of scrap, acid lining calls for superior scrap but cuts down the time of the operation. JDG (6)

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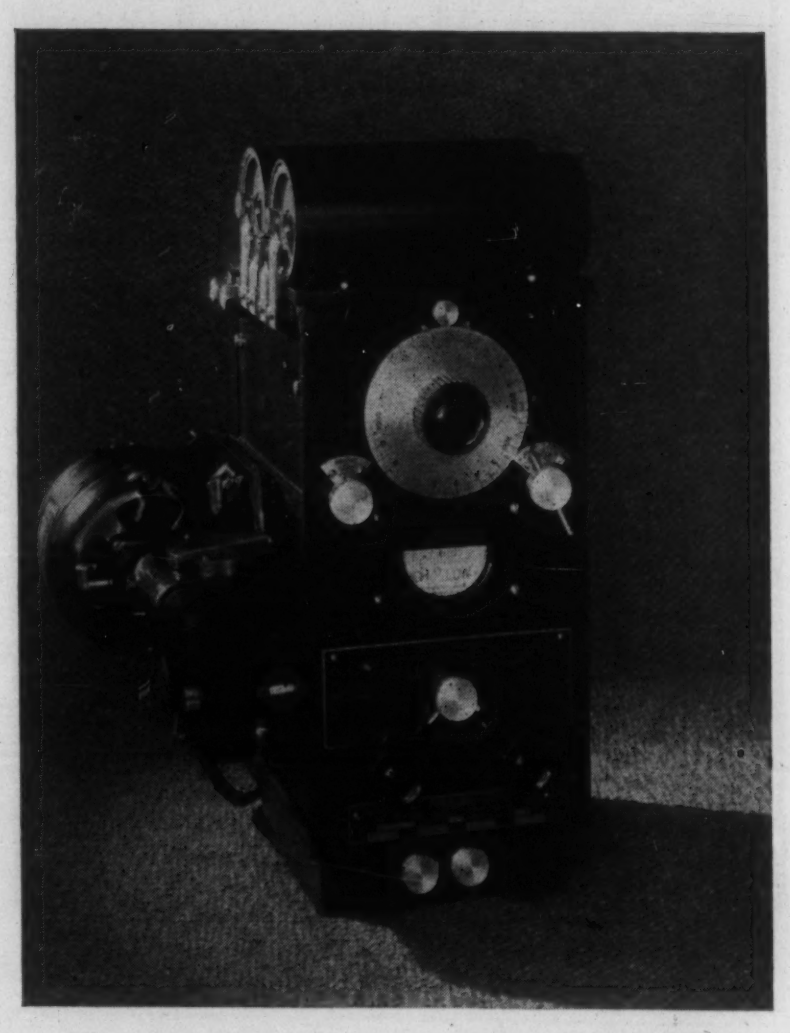

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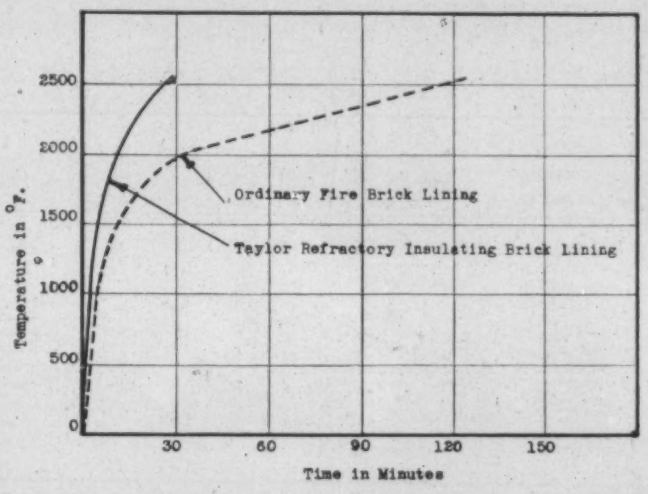

Chart drawn from data obtained on two gas-fire heat-treating furnaces identical except for type of linings.

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Materials for Extreme Temperatures (Materialen voor zeer hooge temperaturen) A. VOSMAER. *Polytechnisch Weekblad*, Vol. 29, Mar. 8, 1934, page 148. Discussed are Al_2O_3, melting point = 2000°C. strong, favorable electric conductivity at high temperatures, chemically resistant against acids and bases. Be-oxide, melting point=2500°C., not resistant against bases, well suited for melting Be (1280°C.) and Zr (1850°C.). Zr-oxide, melting point=2700°C. and withstands 2500°C., has low thermal conductivity and large coefficient of expansion. MgO melts at 2800°C., has a still larger coefficient of expansion, is thoroughly resistant against basic but not against acid attack. Th-oxide, melting point=3000°C., fails on rapid heating. No suitable crucible material has been found yet for W which melts at 3200°C. WH (6)

Electrical Melting Furnaces (Elektrische Schmelzöfen). FR. RUSS. *Elektrizitätswirtschaft*, Vol. 33, June 30, 1934, pages 231-233. Recent German constructions of and practical experiences on (1) arc furnaces of 2000°C. max. working temperature, (2) induction furnaces of 1800°C. max., and (3) resistance furnaces of 1200°C. max. are discussed and illustrated. The first group of furnaces is preferred for ferrous materials, while the induction furnace is principally used for melting brass, bronze, Cu, Cu-Ni, Au and Ag. Experiments with Zn and Al are under way in Germany. Resistance material of Fe-Cr-Al alloys has been recently introduced for max. service temperatures of 1300°C., while C is utilized up to 1450°C. An Al melting furnace of 2 ton capacity and 15-20 ton daily output is shown. The hearth is heated by resistance units placed into the furnace roof. WH (6)

Developments in German High-Frequency Furnace Design. *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, page 394. Recent improvements in furnaces up to 8 tons capacity were obtained by designing the body as a closed vessel which holds the magnetic fields away from the interior vessel by screening. Condensers control capacity and power factor. Frequencies used are from 300 cycles for largest units to 20,000 cycles for small furnaces. A few constructive details are described. Ha (6)

What Industrial Gas Salesmen Should Know About Furnace Atmospheres and Steel. *Gas Engineer*, Vol. 59, July 1934, pages 388-390. Discusses preparatory heating, furnace atmospheres, decarburization, avoidance of decarburization, effect of time, temperature. WH (6)

Make Your Own Electric Furnace. *English Mechanics*, Vol. 26, May 18, 1934, pages 93-96; May 25, 1934, pages 115-116. Full instructions are given on building a wire wound resistance furnace capable of maintaining a temperature of 1100°C., with occasional heating to 1300°C. The structural details can be taken from 9 illustrations. Also describes a small crucible furnace arrangement. WH (6)

Electric Annealing and Hardening Furnaces (Elektrische Glüh- und Härteöfen). *Elektrizitätswirtschaft*, Vol. 33, May 31, 1934, pages 198-199. Discussed are (1) muffle furnace with Nichrome resistance winding for 900°C. max., 1.5-10 kw. input, a.c. or d. c., and (2) muffle furnace with silit resistance bars for 1350°C. max., illuminating gas firing at the furnace door to prevent oxidation and decarburization of high speed steels treated, and 3-130 kw. input WH (6)

High-frequency Melting Furnaces of 4 ton Capacity (Hochfrequenz-Schmelzöfen für 4 t. Einsatz). *Elektrizitätswirtschaft*, Vol. 33, May 31, 1934, page 198. Describes and illustrates tilting German high-frequency furnace built in August 1933. The slag is tapped through a special spout. The furnace can be emptied in 35 sec. WH (6)

JOINING (7)

Thermal Joining Processes and Materials for Aluminum (Gesichtspunkte für die Auswahl thermischer Verbindungsverfahren und deren Hilfstoffe bei Aluminum). L. ROSTOSKY. *Metallwirtschaft*, Vol. 13, July 20, 1934, pages 516-518; July 27, 1934, pages 532-533. Autogenous welds of Al and Al alloys have the advantage, compared with soldering, of high strength, equal color and corrosion resistance. For most types of welding a relatively cheap fluxing powder can be used. Special fluxes are needed for jobs requiring a non-hygroscopic flux and for Al-Mg alloys. As it is not always possible to reduce the grain size of the weld metal by hammering, it is advisable to use a filler rod of different composition from sheet being welded, one especially alloyed to produce small grain size. The filler rod should have a wide solidifying range. When heat treated Al alloys are welded they lose about half their tensile strength. Hard soldering of Al is not practised extensively. It has the advantage over welding of lower working temperature, 500°-620° C. The same fluxes as for welding are used. Al rich alloys, with or without Si, are used as solder. Hard solder is frequently made in the form of a hollow rod with a non-hygroscopic flux in the middle, which is convenient to use. It is also used in shot form. Soft soldering, with Zn or Sn base alloys, can be done at 200°-500° C. Usually no flux is used, but the surface of Al to be soldered is cleaned mechanically. Because of the low temperature there is not much danger of cracking castings, but the process is difficult. Soft soldered joints have low strength, poor corrosion resistance, and often a different color from the parent metal. It is essential to remove excess flux used in these joining processes to prevent corrosion. Washing in H_2O, dilute HNO_3, or HNO_3 and H_2SO_4 is recommended. CEM (7)

Thermal Joining Processes and Materials (Gesichtspunkte für die Auswahl thermischer Verbindungsverfahren und deren Hilfstoffe). L. ROSTOSKY. *Metallwirtschaft*, Vol. 13, Aug. 17, 1934, pages 582-583. Autogenous welding is by far the most important joining process for Mg and its alloys. The process is similar to that used for Al. The ease of welding depends on the solidifying range, coefficient of expansion, strength at elevated temperature, and structure of the alloy. The flux is a mixture of chlorides and fluorides. Soldering is used very little for Mg. For the autogenous welding and soldering of heavy non-ferrous metals, such as Ni and Cu alloys, new fluxes have been developed which are far superior to borax. Better welding rods and hard solders have also been made available by proper alloying. A Cu-P eutectic alloy with a m.p. of 700° C. is now available in wire form. It has been used as a substitute for Ag solder, but is rather brittle. CEM (7)

Soldering & Brazing (7a)

C. H. CHATFIELD, SECTION EDITOR

Hydrogen Brazing Methods. *Gas & Oil Power*. Vol. 29, Apr. 1934, page 115. Discusses the application of H brazing to the manufacture of oil engine parts, i.e., mainly for fitting forged steel reinforcements into the cast steel cylinder cover. The whole work is placed into a furnace filled with H exclusively. For the actual welding a Cu-Ni-Al alloy melting at 1150°C. is utilized. The addition of the latter 2 metals produces a weld which is stronger and less fluid in the liquid state. Too great a fluidity results in the metal flowing right through the jointing spaces without effecting a proper joint. The absence of scale and local internal stresses is emphasized. Other applications of the H brazing process have been made to the building up of piston heads for Diesel engines and fixing of elements going into the construction of high pressure fuel supply systems in airless injection engines. WH (7a)

Soldering, Brazing and Autogenous Soldering. C. V. BOYS. *Journal of Scientific Instruments*, Vol. 11, Apr. 1934, pages 105-111. This article supplements the article on soldering and brazing which appeared in the Nov. 1933 issue of this journal. The author has had wide experience in instrument making and the operations described are chiefly those of soldering and brazing very small metal and alloy articles such as sheet, wire and instrument parts. Methods of preparing fluxes are described. Flux borax is prepared by fusing borax to form a glass after which it is ground and mixed with an oil such as petroleum. An unique method of lead burning applicable to sheets 1/30 inch thick is described. RAW (7a)

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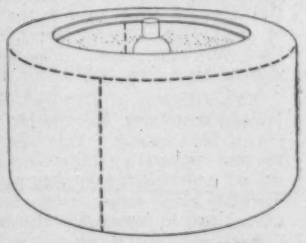
The Rochester 40" O. T. Extractor. Motor driven. With Monel Metal basket and curb. Mfd. by the Rochester Engineering & Centrifugal Corp., Rochester, N. Y. Below: *This diagrammatic sketch shows the location of the welds by dotted lines. The spun Monel Metal top ring No. 13 ga. (.093") is welded to the outer Monel Metal casing No. 13 ga. (.093). The perforated basket side sheet of No. 11 ga. (.125) is welded as indicated. All welds are ground off smooth and polished as shown in the photograph.*



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Oxy-Acetylene...Monel Gas Welding Wire. (For flux, see * below.)
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(for welding of Nickel side)

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•

FLUXES

* Use INCO Gas Welding and Brazing Flux for Monel Metal.
** "Cromalloy" Gas Welding Flux is recommended for Inconel.
† For vertical welding.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

•

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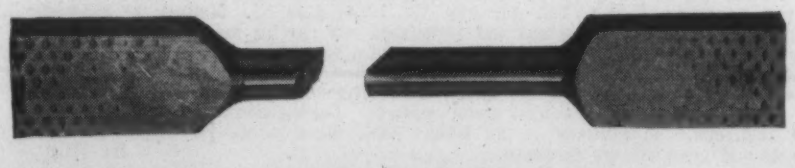
ABOUT WELDS IN HIGH TENSILE STEELS

Welds made in a high tensile alloy steel (C, 0.17-0.25; Mn, 1.0-1.4; P, 0.035; S, 0.04; Si, 0.60-0.80; Cr, 0.40-0.60) possess these properties . . .



Tensile Strength . . . 85,000 to 100,000 lbs. per sq. in. with yield point of 60,000 to 70,000 lbs. per sq. in.

Ductility . . . 15 to 20% elongation in two inches. Free bend test shows 25% elongation of outside fibers. When stress relieved ductility is increased to 25-35% elongation in two inches.

Impact Resistance . . . 60 to 75 ft. lbs. (Izod).

Endurance Limit . . . 45,000 lbs. per sq. in.

Density . . . as measured by specific gravity, 7.82-7.86 grams per c. c.

Corrosion Resistance . . . equal to the steel welded.

In Other Alloys . . . properties of welds made in high tensile alloy steels of other compositions than given above are comparable to the values of the particular steel welded.

How to Obtain . . . weld metal possessing all the above characteristics is produced by the shielded arc with Lincoln "*Shield-Arc 85*" electrodes. Such welds can be made in any position — flat, horizontal, vertical and overhead . . . with "*Shield-Arc 85*" electrodes.

Free samples of "*Shield-Arc 85*" with complete procedure for welding are available upon request addressed to

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Welding & Cutting (7b)

C. A. McCUNE, SECTION EDITOR

Repair Welding of an Aluminum-Cast Motor Housing without Preheating (Reparaturschweissung eines Aluminiumguss-Motorgehauses ohne Vorwärmung). P. WIESSNER. *Automobiltechnische Zeitschrift*, Vol. 37, Sept. 25, 1934, page 473. A large hole in the housing was filled with a piece of Al sheet and both welded together with the oxy-acetylene flame. Ha (7b)

Diesel Engines with Welded Steel Housing (Dieselmotoren mit geschweisstem Stahlgehäuse). M. WIDEMANN. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, June 30, 1934, page 810. Welding of a 12-cylinder V-engine of 1000 H.P.; the housing consists of 7 X-shapes, flame-cut and welded steel parts. Ha (7b)

Lengthening of Frames (Rahmenverlängerung). VICTOR WALTER. *Der Autogen Schweisser*, Vol. 7, July/Aug. 1934, pages 104-106. Deals with the application of fusion welding in the lengthening of truck and bus frames at automobile factories in case of special orders. Technique employed is discussed pointing out the possibility of safe application to trucks which are already in service. Kz (7b)

The Practical Inceptions of a Grid-Controlled Resistance Welding Machine (Die praktischen Anfänge der gittergesteuerten Widerstandsschweissmaschine). K. RUPPIN. *Elektrowärme*, Vol. 4, July 1934, pages 161-162. Grid-controlled resistance welding machines now permit most accurate adjustment of duration of current and connection and disconnection at the desired point of the current wave. Current interruptions up to 1800 per min. have been possible. Welding of stainless steel sheets, of copper sheets, etc. giving oil- and benzine-tight seams, is possible. The control system is described. Ha (7b)

Welded Oil-Field Equipment Built up From Piping. M. L. ROGERS. *Welding Engineer*, Vol. 19, Sept. 1934, page 48. Description. Ha (7b)

The Structure of Metals. Part III. Weld-Metal—A Casting. E. C. ROLLASON. *Welder*, Vol. 6, June 1934, pages 205-209, 214. The mechanism of joining 2 pieces of metal by welding is explained as being essentially a casting process accompanied by crystallization on cooling. Crystallization depends on surface tension, which tends to round the outlines of crystal skeletons; powerful crystalline forces produce angular crystals, e.g. Bi, Sb; viscosity helps to restrict crystal growth to certain axes, and liquid currents give rise to a cellular structure. Ha (7b)

Automatic Welding of Containers (Maschinelle Schweissung von Behältern). E. ROSENBERG. *Petroleum*, Vol. 29, No. 37, 1933, pages 4-5. See *Metals & Alloys*, Vol. 5, July 1934, page MA 337. EF (7b)

Arc-Welding of Non-Ferrous Metals (La Soudure à l'Arc des Métaux nonferreux). RIBEAUCOURT. *Usine*, Vol. 43, July 12, 1934, page 34. Methods of welding copper sheet are briefly reviewed and advantages over riveting pointed out. Electric arc-welding is preferable to oxy-acetylene welding because of the necessity in the latter process of proper rest for the workers. Best welding temperature is about 850° C. to avoid flowing of the metal; an addition of 0.7% Ni to the electrode is advantageous to give the weld proper stiffness. Current density should be about 20 amp./mm.^{2} of electrode at 20 volts. Some other points for preparation of sheets and procedure are discussed. Ha (7b)

Welding of Vehicles (Die Schweissung bei Strassenfahrzeugen). PRZYGODE. *Verkehrstechnik*, Vol. 51, July 12, 1934, page 361. In comparison with (rail) street cars, ordinary transportation vehicles are much more subjected to vibration stresses. The former are mainly exposed to static loads the latter to dynamic ones. Experiences gained on the welding of the former group cannot be entirely applied to the latter type of vehicles. Nevertheless welding has proved to be superior to riveting of ordinary transportation vehicles. Designs incorporating tube members are distinguished by particularly high torsional properties. Cr-Ni steel sheets (.3 mm. thick) are automatically spot welded with success. Due to high welding speeds and low amount of heat supply but little shrinkage stresses are set up. Weld strength = 100 kg./mm.^{2} By cold working the strength of this steel can be raised from 65 kg./mm.^{2} to 150 kg./mm.^{2} WH (7b)

A New Timer for Resistance Welding. R. N. STODDARD. *Electrical Engineering*, Vol. 53, Oct. 1934, pages 1366-1370. In the resistance welding of thin sheets of stainless steel, brass, Al and Al alloys, a high current is applied only for very short intervals of time. A new device, the "ignitron" electronic tube, is described with which precise control of intermittent duty, high-speed automatic duty, and heavy duty seam-welding for any required number of cycles of the current is obtained. Ha (7b)

Cast Iron Arc-Welding of Wobbler Ends of Strip Mill Rolls. C. E. PHILLIPS. *Welding Engineer*, Vol. 19, Sept. 1934, page 25. Describes repair of fractured wobbler ends by building up new ends by depositing weld metal. Ha (7b)

The All-Welded Ship. E. F. SPANNER. *The Welder*, Vol. 6, June 1934, pages 193-195. Electric welding possibilities for the construction of complete hulls are investigated and discussed; successful solution of the problem requires suitable design. Ha (7b)

Does Welding Pay? RALPH STARK. *Bus Transportation*, Vol. 13, June 15, 1934, pages 211-212. Yes, if properly done. Discusses the problems encountered when reconditioning vehicles. Practical advice is furnished including welding Al parts. WH (7b)

Necessary Physical Properties of Weld Metal for Machine Building. E. W. P. SMITH. *Machinery*, N. Y. Vol. 40, Aug. 1934, page 713. Brief discussion of physical properties of weld metals for various purposes. The ductility of the weld must equal that of the material welded, as should also resistance to corrosion. Where ultimate tensile strength is of importance shielded electrodes giving a tensile strength of 70,000-80,000 lbs./in.^{2} should be employed. Ha (7b)

Lower Welding Costs. E. W. P. SMITH. *American Machinist*, Vol. 78, Sept. 26, 1934, pages 665-667. Use of larger electrodes frequently lowers charges for power, labor and overhead. Examples are given. Ha (7b)

Retaining Strength and Ductility in Manganese Steel. G. J. SLIBEK. *Welding Engineer*, Vol. 19, Sept. 1934, page 48. Properties of Mn steel (10-14% Mn) are explained; in order not to destroy by welding, the properties imparted by previous heat-treatment, a welding rod of Ni-Mn with little C should be used containing a proper amount of Si. Ha (7b)

A High Power Welding Rectifier. D. SILVERMANN & J. H. COX. *Electrical Engineering*, Vol. 53, Oct. 1934, pages 1380-1383. An arrangement using the ignitron principle provides predetermined welding currents for periods of time variable in steps of 1/20 sec. or even less. Design and operation are described Ha (7b)

Study of Temperature of the Oxy-Acetylene Flame (Etude de la Temperature de la Flamme Oxy-Acetylenique). D. SÉFÉRIAN. *Revue de la Soudure Autogène*, Vol. 26, July 1934, pages 6-7. Author points out that he has previously shown that differences between calculated temperature and measured temperature of the flame are due to dissociations which take place at high temperature and chiefly that of molecular H into atomic H. He then gives account of the results of Montagne who has studied the combustion: $C_2H_2 + a\ O_2$ in which "a" is the variable percentage of O molecules which are involved in the reaction. Contents of various elements in the flame and temperatures reached as a function of "a" were studied. It is shown that there is a close agreement between values given by Montagne and the previous ones published by the author. FR (7b)

Automatic Welding as Applied to Manufacturing Problems (La Soudure Automatique Appliquée aux Problèmes de Construction). R. SARAZIN. *Science et Industrie*, Vol. 18, July 1934, pages 214-216. Automatic arc welding is divided into metal electrode welding and graphite electrode welding. Machines used are described. FR (7b)

1

Fusion Welding in Motor Car Construction (La Soudure Autogene dans la Construction Automobile). R. SALELLES. *Revue de la Soudure Autogene*, Vol. 25, Mar. 1933, pages 2730-2733. See "Application of Fusion Welding in Motor Car Construction as Seen in the Last Paris Automobile Show," *Metals & Alloys*, Vol. 5, May 1934, page MA 200. FR (7b)

Making Dependable, Speedy, Economical Resistance Welds. CHAS. L. PERKINS. *Welding Engineer*, Vol. 19, Sept. 1934, pages 30-31. Hard-alloy electrodes give neat, economical welds; electrodes of W-Cu and Cd-Cu, and operation are described. Ha (7b)

A Study of Nitrogen in Metallic Arc Welding. JOHN W. MILLER. *Electrical Engineering*, Vol. 53, Sept. 1934, pages 1250-1251. A short review of contents of doctor's thesis on effect of N content of welding atmosphere, C content of electrode, polarity and current in welding. N content of weld metal deposited by the metallic arc process may be diminished by increasing size and C content of electrode, decreasing N content of arc atmosphere and voltage used, increasing current density, and using heavily coated electrodes. Decreased N content leads to improved physical properties. Methods of determining N are described. Ha (7b)

2

Modern Three-Sheet Seams (Moderne Dreiblechnähte). H. MELHARDT. *Autogene Metallbearbeitung*, Vol. 27, Sept. 1, 1934, pages 273-281. Investigations into the strength of welds between 3 plates or sheets have led to the conclusion that the strongest joint is formed when the middle plate of the combination is flush with the underside of the 2 side plates and with gaps between the sheets of definite dimension with respect to their thickness; the edges of the sheets at the seam are *not* tapered. Compared with other welding methods for such joints, less time, less filler material, and less oxygen are required; the saving of this type of weld against the usual fillet weld is about 35% in time and 33% in total cost. Several examples are illustrated and tables show the exact conditions for gaps, flame adjustment, angle of burner to be held against the work, welding time, etc., for plates from 2 to 12 mm. Ha (7b)

3

Reconditioning of Corroded Brass Evaporating Pipes by Means of Fusion Welding (Wiederherstellung korrodierter Messing-Verdampferrohre durch Autogenschweissung). HANS MELHARDT. *Der Autogen Schweisser*, Vol. 7, May 1934, pages 65-67. To save evaporating pipes the end pieces of which were corroded, these ends were cut off and replaced by new pieces of brass pipe by means of oxy-acetylene welding. Discusses the repair work and the physical and chemical tests which were carried out to investigate the safety of working of the reconditioned pipes. Kz (7b)

4

Reconditioning Ice-Cream Mixing Tanks by Welding and Metal Spraying. R. J. MCWATERS. *Welding Engineer*, Vol. 19, Aug. 1934, pages 27-28. Procedure of welding tanks of rustless steel, glass-lined and lead-sprayed is described. Ha (7b)

Welding for Steel Frame Buildings. III. A. RAMSAY MOON. *Welder*, Vol. 6, June 6, 1934, pages 210-214. This instalment deals with construction details and calculation of stresses in an 18 story building and describes erection procedure. Ha (7b)

5

Welding of Refrigerator Parts. L. C. MONROE. *Welding Engineer*, Vol. 19, Sept. 1934, pages 28-29. Description of process and equipment for mass production. Ha (7b)

Electrically Welded Joint in Reinforced Concrete Constructions (Die elektrisch geschweisste Naht im Eisenbetonbau). EBERHARD LUCAN. *Beton & Eisen*, Vol. 32, Apr. 5, 1933, pages 127-129; Vol. 33, Mar. 5, 1934, pages 74-76. Discusses utilization possibilities of electric welded steel reinforcements in concrete and presents cost sheets showing the economy of this joining method. The second instalment of the paper gives the testing results gained on tensile tests with round bars (German standard structural steel St. 37) electric welded in various fashions. Fracture never occurred in the welded section of the samples. In conclusion the solving of difficult problems by electric welding in reinforced concrete is discussed. EF (7b)

6

Reducing Fabrication Costs by Spot Welding. H. K. LIEDY. *Machinery*, N. Y., Vol. 41, Sept. 1934, pages 33-34. Principles and practices of spot welding and equipment used for it are briefly discussed. Ha (7b)

Welding Meeting at Montanistische Hochschule in Leoben, Austria, November 1933 (Schweisstechmische Tagung an der Montanistischen Hochscule Leoben 1933). *Montanistische Rundschau* (Section *Stahlbau-Technik*) Vol. 26, June 16, 1934. The following papers were presented:

Welding Gases, Apparatus, and Auxiliaries in Autogenous Working of Metals (Schweissgase, Geräte und Arbeitsbehelfe der autogenen Metallbearbeitung). VIKTOR WALTER. Discusses the different gases used in welding, the best mixtures and working pressures, and the different types of burners and valves used.

7

Effect of Welding Flame, Basic Materials, Welding Rods and Fluxes, and Reactions in the Melt upon the Technological Characteristics of the Weld for Iron and Non-Ferrous Metals (Die Auswirkungen der Schweissflamme, der Grund- und Zusatzwerkstoffe und der Vorgänge im Schweissbad auf die technologische Charakteristik der Schweissverbindung bei Eisen und Nichteisenmetallen). ERNST GREGER. Gives a comprehensive description of the flame of a welding torch; presents the best gas-oxygen ratio for various conditions and the correct method of placing the welding rod to obtain maximum efficiency and flawless welds. Welding of copper and aluminum discussed briefly.

8

Applications of Welding Methods in Metallurgical Plants (Anwendungsgebiete der Schweissverfahren in Hüttenwerksbetrieben). ROLF 1. RENZENBERG. Describes the repair of rolls, journals, spindles, housings, bearings and other large equipment by welding. A series of ten blue prints not included in the article are available as reprints.

Autogenous Welding in Transportation and in Repair Work; Different Fields of Application (Die Autogenschweissung im Fahrzeug- und Ausbesserungsbau; verschiedene Anwendungsgebiete). VIKTOR WALTER. Deals with the use of welding in the automobile industry, in airplane construction, and in manufacture of furniture and objects of art.

Theory and Practice of Modern Autogenous Cutting (Theorie und Praxis des modernen Brennschneidens). ERNST GREGER. A discussion of the field of flame cutting and flame machining of ordinary carbon steels and certain alloy steels, such as manganese steel, low-chromium steel, and nickel steels. Data are given in regard to proper cutting speed, cutting tolerances, relation of torch size to cutting speed and thickness of plate, and cost.

9

Autogenous Welding in the Construction of Pipe Lines, Apparatus, and Containers, and in Structural Steel Work (Die Autogenschweissung im Rohrleitungs-, Apparate-und Behälterbau und im Eisenhochbau.) ERNST GREGER. A review of progress made by introduction of welding in the construction of pipe lines, pressure vessels, vacuum apparatus, stills, and similar equipment in the chemical field. Welding is also gaining rapid ground at the expense of riveting in the construction of large buildings, bridges, towers for transmission lines, and other structural work.

10

Electric Welding in Mine and Plant Railways (Elektroschweissung bei Gruben- und Werksbahnen). GEORG HAFERGUT. Important savings in cost and reductions in weight of 20 to 30%, compared with riveting, are frequently attained in repairing locomotive boilers, car frames, fire boxes, and other heavy parts. BHS (7b)

The Electric-Arc Welding Process. Some Metallurgical Aspects. WILLIAM BARR. *Sheet Metal Industries*, Vol. 8, June 1934, pages 368-370. Paper before a meeting of the West of Scotland Iron & Steel Institute, Glasgow. See *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 405. AWM (7b)

What the Maintenance Engineer Should Know About Arc Welding. FRED D. HARTFORD. *Mill & Factory*, Vol. 14, Apr. 1934, pages 32-33, 92. Deals with welding technique, welding rods, types of welds and their strength. Kz (7b)

Welding on the Boulder Dam Cylinder Gates and Nose Liners. CHAS. H. JENNINGS. *Welding Engineer*, Vol. 19, July 1934, pages 17-22. Describes and illustrates welding procedures, assembling of large parts, constructive details, strain-relieving at 1300° F. Ha (7b)

Studies of the Metallurgy of Arc Deposited Weld Metal. SAMUEL L. HOYT. *American Society for Metals*, Preprint No. 20, 1934, 24 pages. Weld metal deposited from cellulose type weld rod and bare rod is described as to analysis, mechanical properties and structure. Bare wire deposits metal of lower C content than cellulose coated wire. Features of analysis of latter type of weld metal are Si above that occuring in wire and probably comes from reduction of silica in coating and high O_2 content which is found by fractional O_2 determination and microscopic examinations to occur at a fine silica dispersion. Mechanical properties show Brinell hardness 120, endurance limit 30,000 lbs./in.², Charpy 30-40 ft. lbs., tensile 55,000-60,000 lbs./in.², yield 40,000-45,000 lbs./in.², elongation 30-40% and reduction of area 45-55%. Bare wire deposits metal abnormal and coated wire normal to McQuaid-Ehn test. Weld metal from bare wire is strong when properly made but lacks many of qualities which characterize the plate it joins. Cellulose coated wire gives a weld metal that is strong, tough and ductile to a degree entirely adequate for any service for which it is properly designed. WLC (7b)

Chemical-Plant Fabrication. Some Notes on Welding Technique. J. HINDE. *Chemical Trade Journal & Chemical Engineer*, Vol. 92, May 12, 1933, page 375. Gives precautions to be observed for securing sound welds in mild steel, stainless steels, Ni, Monel metal, Cu, Al, etc. JN (7b)

Investigations on Welds of Rust and Acid Resisting Steels (Untersuchungen an Schweissungen aus nichtrostenden und säurebeständigen Stählen). R. HESSLER & K. KAUTZ. *Die Elektroschweisssung*, Vol. 5, May 1934, pages 81-88. The increasing application of welded containers and apparatus of rust and acid resisting steels in the chemical and related industries led to this investigation. Steels of the following composition were welded and tested.

Steel brand	C % about	Si % about	Mn % about	Ni % about	Cr % about	Ti % about	Mo % about
KA2 normal & special	.08-.15	.5	.4	8.0	18.0	—	—
KA2 extra	<.12	.5	.4	8.0	18.0	.5	—
KA2 supra	<.07	.5	.4	8.0	18.0	—	—
KA4 normal	.08-.15	.5	.4	9.0	18.0	—	2.5
KA4 extra	<.12	.5	.4	9.0	18.0	.5	2.5
KA4 supra	<.07	.5	.4	9.0	18.0	—	2.5

KA2 normal and KA4 normal steel require special heat treating (heating to around 1100° C. and water quenching) subsequent to welding, KA2 extra, KA4 extra, KA2 supra, KA2 special and KA4 supra steel do not require subsequent heat treatment since they do not show detrimental carbide precipitation favoring corrosion attack. There are discussed in detail the results of mechanical and technological tests comprising (1) welding of 25 mm. thick KA2 normal and KA2 extra steel plates, (2) bursting test on welded container of KA2 normal steel, (3) falling test with a beer storing tank of KA2 special steel for determining applicability of material for transportation of acids, inflammable liquids and the like, (4) accidental tests of welded KA2 containers due to service accidents. The extensive results of tensile tests, notched bar impact tests, cold bending tests and X ray test are tabulated, micrographs are shown. The described tests and investigations go to show that non-rusting steels can be processed reliably. The exceptionally high plasticity and insensitivity towards notch effects of austenitic KA2 welds in combination with other good technological properties guarantee safe and sound weld joints and make them fit for mentioned purpose. GN (7b)

Principles of Construction and Data on Tensile Strength which have to be Observed in the Construction of Welded Apparatus made from Non-ferrous Metals (Konstructionsgrundsätze und Festigkeitswerte für den Bau von geschweissten Apparaten aus Nichteisenmetallen). ERNST GREGER. *Der Autogen Schweisser*. Vol. 7, Apr. 1934, pages 59-61. Deals with the production of those parts which are frequently used in the construction of apparatus. The most suitable form of these parts, the kind of weld to be applied and where it has to be located to secure the highest possible strength are discussed. Data on tensile strength, elongation, and permissible load of Cu, Al, Ni, brass and welds of these materials are given. Kz (7b)

Progress in Oxy-acetylene Welding (Les Progres de la Soudure Oxy-Acétylénique). R. GRANJON. *Revue de la Soudure Autogène*, Vol. 26, Mar. 1934, page 1. It is now possible to weld 10 mm. thick steel plate at a speed of 2 meters per hour with a consumption of 240 liters C_2H_2 and 280 liters 0 per meter of welded seam. With 20 mm. thick plate speed of welding is 1 meter per hour with a consumption of 900 liters C_2H_2 and 1,100 liters 0 per meter of welded seam. Such results are obtained using 2 low power torches working in given conditions on each side of plates. FR (7b)

Characteristics for the Dynamic Behavior of Arc-Welding Machines (Ueber die Kennzeichen für dynamisches Verhalten von Lichtbogenschweissmaschinen). A. GRABNER. *Elektrotechnik & Maschinenbau*, Vol. 52, June 3, 1934, pages 249-254. Recent development of electric arc-welding machines is discussed with special consideration of their behavior, i.e., voltage and current characteristics, and means of regulation, under interruption and after disconnection. Ha (7b)

Lithium Salts and Lithium Ores for Welding. G. H. CHAMBERS & E. J. ENCK. *Chemical Industries*, Vol. 34, May 1934, pages 405-408. The chief lithia minerals are amblygonite, spodumene, lepidolite and triphylite-lithiophylite. Properties and uses of a few lithium salts are given. Lithium chloride and lithium fluoride find use in the welding of non-ferrous metals—especially aluminum. RAW (7b)

Arc-Welding Aluminum. A. F. DAVIS. *American Machinist*, Vol. 78, June 20, 1934, pages 438-439. Electrode used for Al-welding is a heavily-coated rod of the shielded arc type and connected in reverse polarity, i.e. to the positive pole, and the work to the negative. Porosity in the weld can be avoided by heating the plates on each side of the seam to about 600°-700° F. Sketches show assembly of parts for different type of welds and procedure. Ha (7b)

New Texas Observatory Is Built of Arc Welded Steel. *Steel*, Vol. 95, July 23, 1934, pages 41-42. Describes design and fabrication of the dome for the McDonald observatory, University of Texas. MS (7b)

Heavy-Duty Power Presses of Welded Plate Construction. *Steel*, Vol. 95, Aug. 6, 1934, pages 34-35. Describes presses built by E. W. Bliss Co. MS (7b)

New Welding Method for Rails (Ein neues Schienenschweissverfahren). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, June 3, 1934, pages 358-359. New welding method described combines pressure and fusion welding method in that rail heads are fusion welded while web and flange are pressure welded, i.e. this method is a reversal of former combination welding method of rails. Method means a considerable saving of working time and fuel. GN (7b)

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FINISHING (8)

H. S. RAWDON, SECTION EDITOR

Metal Finishes Used in Modern Architecture. S. WERNICK. *Synthetic & Applied Finishes*, Vol. 5, June 1934, pages 60-71. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 449. EF (8)

Pickling (8a)

Blisters on Zinc and Steel Sheets and Hollow-ware Due to Pickling. OTTO VOGEL. *Sheet Metal Industries*, Vol. 8, July 1934, pages 409-411. See "Pickling Blisters on Galvanized and Black Steel Sheet," *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 485. AWM (8a)

Cleaning, including Sand Blasting (8b)

A Modern Rod Cleaning Installation. ALBERT F. CARL. *Wire & Wire Products*, Vol. 9, Aug. 1934, pages 237-239, 259. Straight-line cleaning system, equipment and pickling methods are described. Ha (8b)

Cleaning of Large and Intricate Castings by Water Jets. (Das Putzen grosser und komplizierter Gussstücke mit Wasserstrahl). *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, July 22, 1934, pages 300-304. After discussing disadvantages of removing cores by compressed air, the author considers cleaning methods and implements utilizing high pressure water. The outfit of Badische Maschinenfabrik Durlach is described which uses rather small nozzles and H_2O pressures of 50-100 atm. With such high pressures, the cleaning capacity increases much more rapidly than the power consumption. Furthermore the water consumption is lower than for pressures of around 30 atm. The operation of the outfit is described at length. Cleaning of various types of castings is outlined, as air valve castings of open hearth furnaces, cylinder bottoms of a compressor, a turbine casing and others. GN (8b)

Polishing & Grinding (8c)

Actual and Measured Degree of Fineness of Ground Surfaces (Tatsächlicher und gemessener Feinheitsgrad geschliffener Flächen). A. LINDAU. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Aug. 4, 1934, pages 941-942. A method is described for determining deviations of a profile as obtained by machining from the outline it actually should have. This fineness is a direct measure of the roughness of the surface and depends on the tool and on the accuracy of the machine. Mathematical relations were derived for calculating the deviations for tools with differently curved edges or points. 3 references. Ha (8c)

Notes on the Performance of the Bearing Metal as Determined from the Results of Experiments. SHINTA MATSUNAWA & MOTOMU ISHIDA. *Journal of the Society of Mechanical Engineers*, Vol. 37, Mar. 1934, pages 125-131. (In Japanese). Paper read before the Extraordinary General Meeting of the Society of Mechanical Engineers at Kôbe, Nov. 3, 1933. Tests were carried out under service conditions to determine the friction between bearings and axle journals. Difference in frictional resistance according to methods of finishing the axle surface was determined and the relative merits of various finishing methods pointed out. Tests showed that the frictional resistance of the bearing lined with a thin layer of white metal, is about ¼ that of the ordinary bearing made of gun metal. Kz (8c)

Sharpening Intricate Cutters. H. Isler. *American Machinist*, Vol. 78, Aug. 1, 1934, pages 530-532. Best current practice in grinding and modern equipment are described. Ha (8c)

Polishing and Buffing Costs. John E. Hyler. *American Machinist*, Vol. 78, Sept. 12, 1934, page 641. Brief discussion of factors tending to reduce the usual high cost of polishing and buffing. Ha (8c)

Polishing of Aluminum Parts in the Ball Drum Mill (Das Polieren von Aluminiumteilen in der Kugeltrommel). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, May 20, 1934, pages 308-309. Al parts of mass production are suitably polished in drum mills. Parts with smooth surface are particularly well suited for this type of polishing. The procedure is outlined. GN (8c)

Electroplating (8d)

Wet Chromiumplating (Nass-Verchromung). F. Dobrovsky. *Oberflächentechnik*, Vol. 11, July 17, 1934, pages 155-156. Several cases were investigated of highly polished Cr plated articles which developed a kind of rusty appearance and lost their gloss. It was found that in almost all cases some chromic acid remained on the surface or that improper temperature control during plating caused the failure. Such failures were eliminated when the object was introduced into the bath while still wet after being sprayed with water. Cr deposits made in this manner are said to resist attack of HCl longer than deposits made in the usual manner under otherwise corresponding conditions. Ha (8d)

Principles of Electrodeposition (Prinzipien der Galvanotechnik). J. Billiter. Julius Springer Verlag, Vienna, 1934. Cloth, 6¼ x 9¼ inches, 326 pages. Price 22.50 RM. Without attempting to prepare a handbook of electroplating, the author has included a very large amount of reliable information regarding the solutions and conditions used in commercial work. This information is employed to develop and illustrate the principles, which are clearly stated and explained. The author has not merely quoted or referred to almost every important research in this field, but he has also analyzed the different views and pointed out their value and limitations. In numerous connections the lack of pertinent data and hence the inadequacy of present theories are emphasized. The author has also given data and illustrations from unpublished work by him and his associates, the further details of which will be awaited with interest. In general the references are very complete and reliable. One error should be noted, especially because of the present interest in the history of chromium plating. On page 222 the author gives credit to Reese for reporting "that chromium can be deposited from chromic acid only with the addition of small amounts of sulphate." Reference to the original article shows that Reese reported only the electrolytic reduction of chromic acid, and gave no evidence that he obtained metallic chromium. The outstanding portion of the book is the "general part," in which nearly 100 pages are devoted to a critical exposition of the factors that influence the structure and distribution of electrodeposits. The selection and printing of the photographs of structure are excellent The book will be especially useful to research workers in electrodeposition, on account of its complete bibliography, its clear, concise summaries, and its suggestions of problems in need of study. W. Blum. (8d)—B—

Hard Facing, Inserts and Plating Satisfy Hardness Requirements. Allen F. Clark. *Machine Design*, Vol. 6, June 1934, pages 29-30; July 1934, pages 30-32. Part I. Deals with the use of W carbide inserts, which can be made in practically any shape. W carbide has a 91 Rockwell C hardness and the highest compressive strength of any commercial material, is resistant to most acids but cannot withstand extreme shocks. Utilizations: hydraulic press valve stem and seat inserts, guides for wire, paper products, threads, leather, steel parts being processed in welding machines, nozzles, chip breakers, master cams, grinder, lathe rests. Part II. Pertains to a discussion on the utilization of Cr plating as wear and abrasion resisting surface. Claims that electro-deposited Cr is harder than any form of case hardened steel. It is resistant to S compounds, SO_2, H_2S, atmospheric corrosion and insoluble in HNO_3 and alkalis as well as in most organic acids. The base metal must provide the strength required. Cr plating is successfully used on steel shafts running in Zn die-cast bearings. Plain steel shafts frequently freeze to the bearing. Cr plated shafts in intermittently operating water pumps prevent corrosion during idling. Previously freezing of the shaft to the bearing was noticed. Further applications of Cr plating are: textile machinery parts, ceramic sludge pump linings, cylinders of outboard motors, linings of blowers passing dirty or gritty substances, steam turbine blades, oil cracking equipment, slots, screen and press plates in paper industry, Cu tank linings, drying, metal finishing calendar, Schreiner and cloth printing rolls, gages, tools and dies, bearings, cams, valve seats, thread guides, gears, etc. WH (8d)

Nickel Plating of Aluminum (Zur Vernicklung des Aluminiums). W. Fröhlich. *Die Metallbörse*, Vol. 24, Mar. 31, 1934, pages 405-406; Apr. 7, 1934, page 439; Apr. 14. 1934, pages 469-470. Rapid oxidation of Al and its electromotive potential with respect to other metals are mainly responsible for the peculiar conditions prevailing during Ni plating of Al. Thorough cleaning of the Al is highly important, steel brushes or sand blasting being unsuitable. Soft brushes and soap suds are recommended. A chemical surface treatment is indispensable. Acid and alkaline solutions (pH = 10) are in use. Failures can be partly ascribed to too high pH values of 12-13. Chromates and silicates are added as inhibitors to alkaline cleaning solutions. Borates and phosphates facilitate the rinsing off of the latter. The best working temperature is 95°C. while 100°C. may result in complete failure. The following mixtures are recommended: 56% calcined soda, 5% caustic soda, 9% Na aluminate, 30% tri-Na-phosphate. Discoloration of Al during pickling is eliminated by dilute HNO_3, H_2SO_4 or HF. Hot H_2O is used first for washing and then cold H_2O, contrary to the practice in pickling brass, bronze, and steel. The next step, metallization, is accomplished by dipping into a H_2SO_4 or HNO_3 solution of a ferrous salt. Better results are claimed for a solution of 400 ml. H_2O, 10 ml. HCl, 9 g. $CdCl_2$ and 2 g. NH_4F. Immersion time = 15 sec. Quick rinsing off and immediate Ni plating in solution containing 50 g. Ni sulphate + 35 g. Na citrate/liter H_2O is advised. Directions for pickling pure Al, rolled and sand cast material and for utilization of intermediary layers of brass, Zn, Cu, Cr are given. The following electrolytes are also recommended (g./liter H_2O): (1) Ni sulphate = 115, Mg sulphate = 60, NH_4 chloride = 30, boric acid = 30. Temperature = 30°-35°C., current density = 1.5 amps./dm.², pH = 5.8-6. (2) Ni-sulphate = 135, Ni-NH_4 sulphate = 22.5, Na chloride = 15, Mg sulphate = 7.5, boric acid = 15. Temp. = 20°C., current density = 1.65 amps./dm.² time = 15-60 min. (2) is particularly suitable if Ni is deposited on an intermediary layer of brass. Ni plated Al parts are heat treated as follows: 1-2 hrs. at 120°C. slow heating to 195°-200°C., annealing for several hours at 200°C., and slow cooling. EF (8d)

Method to Determine Copper and Nickel Plate Thickness on Steel, Brass and Zinc Die Castings. Fred Carl. *Metals & Alloys*, Vol. 5, Feb. 1934, pages 39-42. See "Measuring the Thickness of Electro-Plates," *Metals & Alloys*, Vol. 5, July 1934, page MA 341. WLC (8d)

The Electroplating of Castings. B. Caplan. *Foundry Trade Journal*, Vol. 50, Mar. 15, 1934, pages 183-184; Mar. 22, 1934, pages 200-202. See *Metals & Alloys*, Vol. 5, July 1934, page MA 341. OWE (8d)

The Electrodeposition of Rhodium. R. H. Atkinson & A. R. Raper. *Metal Industry*, N. Y., Vol. 32, Apr. 1934, pages 119-121. See *Metals & Alloys*, Vol. 5, June 1934, page MA 272. PRK (8d)

1 **Automatic Devices in the Chrome-Plating Industry.** *Engineering Progress*, Vol. 15, Aug. 1934, pages 163-164. Economic advantages of Cr-plating are pointed out. Automatic plants shorten the time required for the deposit, give a higher quality of metal deposits and a considerable increase in the uniformity of coating thickness. Control of working process and calculation of cost are simplified and production increased. A few installations are described. Ha (8d)

—— **Importance of $_pH$ in Electrolytic Deposits (Role du $_pH$ dans les Depots Electrolytiques).** M. Ballay. *Usine*, Vol. 43, July 19, 1934, page 37. See "Electrolytic Deposition of Nickel in Solutions of pH Values above 7.0," *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 406. Ha (8d)

2 **Prevention of Formation of Pores in Electrolytic Nickel Deposits (Ueber die Verhütung der Porenbildung bei galvanischen Niederschlägen).** W. Eckhardt. *Oberflächentechnik*, Vol. 11, Aug. 31, 1934, page 178. Fine-grained, pore-free deposits of Ni satisfactory for subsequent Cr plating, are obtained in a bath of 80 g. $NiSO_4$, 8 g. NiF_2, 1 g. NaF, 1 g. NaCl, 1.02 g. $NaNO_3$, 0.12 g. phenol sulphosodium, 0.50 g. $MgSO_4$, 2.0 g. sodium citrate, 6 g. boric acid, per 1 H_2O. The bath can be used at room temperature and gives at 2v. a dark dull deposit which can easily be polished and gives good protection against corrosion. Ha (8d)

—— **Economical Viewpoint in the Electrolytic Galvanizing of Iron and Steel Strips. (Wirtschaftliche Gesichtspunkte bei der elektrolytischen Verzinkung von Eisen-und Stahlbandern).** H. Meyer auf der Heide. *Oberflächentechnik*, Vol. 21, Sept. 25, 1934, pages 202-204. An advantage claimed for electrolytic over hot 3 galvanizing is that Zn can be deposited perfectly uniformly to any desired thickness and the union between basis metal and Zn is so perfect that mechanical deformation does not cause spalling. Such material can be rolled, drawn and stamped. Electroplating is employed especially for cold-rolled Fe strip and hardened steel strip in order that no change in their properties shall occur during galvanizing. High purity of the materials is imperative for successful galvanizing. A modern —— installation is described; the electrical energy required can be calculated from the fact that 1 amp. hrs. deposits in practice, 1.1. g. Zn (theoretically 1.2 g.). [Ed. note: 14 Amp. hrs./ft.² deposit 0.001" coating of Zn]. An example illustrates mode of calculation of the different items making up the total costs. Ha (8d)

4 **The Hydrogen Content and the Hardness of Electro-Deposited Metals (Sur la teneur en hydrogène et la dureté des métaux électrolytiques).** M. Guichard, Clausmann, Billon & Lanthony. *Bulletin de la societe chimique de France*, Vol. 5, May 1934, pages 679-688. See "Hydrogen Content and Hardness of Electrolytic Chromium," *Metals & Alloys*, Vol. 5, July 1934, page MA 341. EF (8d)

—— **Adhesion and Cause of Non-Adhesion of Electrolytic Deposits (Adesione e Cause di Non-Adesione dei Depositi galvanici).** V. P. Sacchi. *L'Industria Meccanica*, Vol. 16, May 1934, pages 343-349; June 1934, pages 356-361. Adhesion of electrolytic deposits on the basis metal depends on the mutual attraction exerted by the molecules of the two contact surfaces. Maximum adhesion is obtained when the surfaces are in molecular contact, and does not exceed the value of cohesion 5 of the weaker metal. Molecular contact can be facilitated by formation of an alloy of the basis metal and the deposit or by a proper mechanical preparation of the basis metal. All causes which tend to prevent molecular contact are favorable to non-adhesion and can be eliminated by a correct preparation of the basis —— metal before deposition and by the use of electrolytes properly selected according to the properties of the basis metal. One reason for non-adhesion is internal stresses set up in the deposit and in the metal during deposition and which persist after deposition. These stresses exert a force of uniform tension perpendicular to the covered surface which tends to lift the deposit from the basis metal. They can be reduced considerably by proper operating conditions. These points are discussed and explained by the chemical reactions taking part in electrolytic plating 6 of metals. 27 references. Ha (8d)

—— **Anodic Behavior of Ferrous Metals (Ueber das anodische Verhalten der Eisenmetalle).** W. J. Mueller. *Korrosion & Metallschutz*, Vol. 10, Jan. 1934, pages 1-5. Different theories to account for the passivity properties of Fe, Ni and Co are discussed. The author maintains that the anodic behavior of all metals —— depends not only on potential and current but also on time which in other investigations has been disregarded. Ferrous metals need a higher potential for their dissolution than the reversible potential as is the case of the non-ferrous metals which dissolve with their reversible potential. Experiments are cited in support of this fact. Ha (8d)

7 **Symbols of the Phase Rule and Electrochemistry (Symbole der Phasenlehre und der Elektrochemie).** E. Lange. *Zeitschrift für Elektrochemie*, Vol. 40, Sept. 1934, pages 655-661. Symbols are proposed to make it possible graphically to distinguish between single and poly-phase systems in the chemical and electro- —— chemical equations of state. For example a right angle drawn around the atom or molecule symbol denotes a phase, a symbol underlined once indicates the liquid, underlined twice, the solid; and not underlined, the gas phase. With the symbols —— it becomes possible to show graphically phase changes and poly-phase equations in which no molecular change takes place, potential producing ions and double layers of electrochemical two phase systems, electrochemical three and four phase systems, with and without resultant potential, etc. WB (8d)

8 **Injurious effects of Solutions Used in Chromium-plating and Relative Hygienic Standards (L'Azione nociva delle Soluzione usate per la Cromatura e Norme igieniche relative).** O. Macchia. *L'Industria Meccanica*, Vol. 16, July 1934, pages 566-569. Diseases which Cr platers often develop, clinical symptoms and regulations and equipment to eliminate these effects are discussed. Ha (8d)

—— **Electrolytic Deposition of Iron (La Deposizione elettrolitica del Ferro).** O. Macchia. *L'Industria Meccanica*, Vol. 16, Aug. 1934, pages 639-641. Brief history of Fe deposition is given and the various solutions proposed for it are described. Best results have been obtained with the following 3 baths: (1) Fisher-Langbein; 450 g. ferrous chloride, 500 g. calcium chloride, 750 ml. H_2O; current density above 20 amp./dm²., temperature not lower than 90° C. (2) W. E. Hughes; 300 g. crystallized ferrous chloride, 335 g. crystallized calcium 9 chloride, 1000 ml. H_2O; current density 20 amp./dm²., temperature 90° C. (3) W. Pfannhauser; 130 g. ferrous sulphate, 100 g. ammonium chloride, 3 g. sodium citrate, 1000 ml. H_2O; current density 0.1 amp./dm²., temperature 15°-20°C. Current density, temperature and acidity of the solution must be maintained with narrow limits during the process if good results are to be obtained. Electrolytic Fe deposits are usually employed to improve the hardness of a surface. Ha (8d)

—— **Investigation of the Process of Mutual Displacement of Metals (Untersuchung des Prozesses der gegenseitigen Verdrängung von Metallen).** N. Isgarischew & I. Mirkin. *Korrosion und Metallschutz*, Vol. 10, May 1934, pages 109-112. The process of mutual displacement of metals such as occurs practically in method of producing protective coatings on metals, or as corrosion, is studied by the 10 displacement of Cu, Cd, Pb, Ni, Fe and Co by Zn powder in the presence of different anions. Evolution of H from neutral solutions is of special importance as H is activated particularly in presence of Ni, Fe, Co, Cr and Cl ions. The displacement in its different forms is explained by the different overvoltages of H in presence of the metals on the Zn which form galvanic elements together. Ha (8d)

Electrolytic Potential of Ni (Sur le Potentiel Électrolytique du Nickel). L. COLOMBIER. *Comptes Rendus*, Vol. 199, July 23, 1934, pages 273-275. True potential of Ni in *N* $NiSO_4$ determined to be, $E_h = -0.227 \pm .002$ volt at 20° C. Check results were obtained with commercial Ni, with Ni electrodeposited at high current density and with Ni produced by H_2 reduction; all samples annealed at 500° C. in vacuo to remove adsorbed gas. Potentials, measured in relation to calomel electrode, were calculated with normal H electrode as zero. FHC (8d)

1

Variations of Electrolytic Potential of Ni with Acidity (Sur la Variation du Potentiel Électrolytique du Nickel avec l'Acidité). L. COLOMBIER. *Comptes Rendus*, Vol. 199, Aug. 6, 1934, pages 408-409. Electrolyte of *N* $NiSO_4$ was used to which H_2SO_4 was added in increasing amounts. Curve shows that Ni potential is independent of the pH value up to point where potential is equal to that of H electrode for the same solution. For greater acidities (pH less than 4), potential rises and becomes directly proportional to pH. FHC (8d)

Manufacture of Sheets of Electrolytic Copper (La Fabrication de la Planche de Cuivre electrolytique). M. ALTMEYER. *Cuivre et Laiton*, Vol. 7, Aug. 30, 1934, pages 367-370. Large sheets of pure Cu are made by electrodeposition of Cu on rotating cathodes of cast iron or steel of 4 m. length and 68 cm. diam. (2.15m. circumference). The cylinders thus produced, if not used as such, are cut open, straightened and annealed. Current density is 425 amp./m².; the cathode rotates, 30-40 r.p.m. The cathodes are fully submerged in the electrolyte which is actively stirred during the process. In order to facilitate the removal of the deposit from the cathode, the latter is coated with a special lacquer. The sheet Cu, as deposited, has a tensile sterngth of 28 kg./mm²., elongation 34%; after annealing the figures are 21 kg/mm². and 48-50% resp. Sheets from 0.2 to 0.7 mm. are generally made but sheet of greater thickness is also made. Plant equipment for 60-90 tons production per month is described. Ha (8d)

2

Electroplating of Alloys containing Chromium (Die Galvanisierung chromhaltiger Metalllegierungen). *Oberflächentechnik*, Vol. 11, July 3, 1934, pages 144-145. Electrolytic deposits often adhere very loosely on alloys containing chromium. It is recommended to dissolve the Cr from the surface before plating by immersion in warm 30% HCl until gas is evolved. After rinsing in water the objects can be plated in acid baths; alkaline or cyanide baths are not suitable, but after an initial deposit in an acid bath a cyanide bath can be used for further deposition. Another method (D.R.P. 551980) of obviating this difficulty is to brush a thin film of a kind of solder over the surface as intermediary layer on which the metal can be deposited; the intermediary layer can consist of Zn, Sn, Cd and Pb. The process of Koepf (D.R.R. 585708) does not necessitate a pretreatment but the Cr-containing or pure Cr surface is exposed during electroplating to strongly acidic solution (pH of 2.5 and less). The explanation is advanced that strongly acid baths overcome the passivity of Cr and activate it so that a deposit adheres very firmly; however, thick deposits should not be made in this manner as they contain much H. It is advisable to deposit only a very thin initial layer from the strongly acid bath and plate further in a normal bath. An acid bath for Ni plating is recommended: 1 l. H_2O, 200 g. $NiSO_4$ 30 g. Na_2SO_4, 20 g. boric acid. 10 g. NH_4Cl, to which H_2SO_4 is added until the desired acidity is obtained. A similar process is described in Austrian patent no. 136978. Ha (8d)

3

Theory of Chromiumplating (Theorie der Verchromung). ERICH MUELLER. *Zeitschrift für Elektrochemie*, Vol. 40, June 1934, pages 326-337, July 1934, pages 344-352. The author sets out to prove that the theory of deposition of Cr from chromic acid solutions as given by E. Liebreich (see *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 486) is not supported by facts and again develops his own theory which is based on the fact that the e.m.f. on a graphite electrode in an aqueous solution of pure chromic acid under cathodic polarization shows a definite discontinuity where the e.m.f. becomes negative and where the evolution of H starts. This is explained on the assumption that the electrode is covered, during passage of the current, with a non-conducting diaphragm or film, which bars the chromic acid from reaching the cathode and hinders further reduction of it. Although the formation of such film is generally accepted, particular emphasis is laid upon the assumption that the film must be permeable for H-ions as otherwise they could not be discharged which is the case even after the discontinuity in the curve has been passed. The author assumes, therefore, a selective permeability of the diaphragm for different ions which must necessarily bear some relation to the size of the ions. If metal instead of graphite is used for the cathode the same conditions prevail qualitatively, but differ greatly quantitatively. This is explained by the marked differences in surface qualities of graphite and metal. As all metals are attacked by chromic acid, a primary diaphragm is formed by chemical action while the current forms a secondary diaphragm. The presence of anions of foreign acids changes the e.m.f.'s after the discontinuity of the current curve. This is discussed and demonstrated by H_2SO_4 and HF; boric acid is almost without effect. Addition of HF to chromiumplating solutions gives a better throwing power than addition of H_2SO_4, and furthermore, a bright deposit can be obtained with the former at room temperature, with H_2SO_4 only at higher temperature. This is ascribed to HF being a considerably weaker acid than H_2SO_4 and having a lower anion concentration. The original should be consulted for experimental proof of the author's statements. 37 references Ha (8d)

5

Metallic Coatings other than Electroplating (8e)

Tin-Iron Alloy in Tinplate with Notes on Some Imperfections. W. E. HOARE. *Sheet Metal Industries*, Vol. 8, July 1934, pages 285-390; *Iron & Coal Trades Review*, Vol. 129, July 6, 1934, pages 4-5; *Iron & Steel Industry*, Vol. 7, June 1934, pages 299-300. Paper read at the Annual Meeting of the Iron and Steel Institute. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 486. AWM + Ha + CEJ (8e)

Improvements in Galvanizing Practice (Verbesserungen in der Verzinkereipraxis). H. BABLIK. *Oberflächentechnik*, Vol. 11, June 19, 1934, pages 133-135. Tanks containing the molten Zn are subject to deterioration for 2 reasons; firstly local overheating, due often to the collection at the bottom of hard zinc which because of its lower heat conductivity permits the tank to become hotter here than at other places. However, the higher solubility of Fe in Zn at higher temperatures favors rapid local attack on the inside of the tank. The second cause relates to conditions outside of the kettle; overflowing Zn, which contains always some zinc chloride penetrates through the brick work and comes into contact with the outside of the tank. Zn chloride (often mixed with ammonium chloride) dissolves Fe very strongly as is illustrated by the tabulated results:

Composition of liquid	loss in g./m.²	Constant, [relative loss]
$ZnCl_2$	26	7
$ZnCl_2$ with 5% NH_4Cl	114	29
$ZnCl_2$ with 10% NH_4Cl	591	150
$ZnCl_2$ with 16.6% NH_4Cl	1365	370

The formula $L = K\sqrt{t}$ can be used to calculate the amount of Fe dissolved, L is loss, K the above constant, t = time in min. A remedy for this condition is to prevent access of zinc by welding Fe plates protruding over and covering the edges of the brickwork; they can be easily exchanged when worn. In order to obtain a Zn layer of uniform thickness the sheet is dipped vertically and gradually lifted out as it moves forward at a velocity which does not allow the liquid Zn to freeze on the emerging sheet. Ha (8e)

Surface Treatment and Surface Protection of Aluminum and Aluminum Alloys (Oberflächenbehandlung und Oberflächenschutz von Aluminium und Alumium-legierungen). H. ROEHRIG. *Korrosion und Metallschutz*, Vol. 10, June 1934, pages 135-142. Treatment of surfaces of pure Al and Al alloys to increase their resistance against corrosion and against chemical influence is discussed. Because of inclusions in the metal which form local elements, internal corrosion may take place and the appearance of the surface be quite deceiving. Al alloys containing elements which are more electro-positive than the basis metal are more in need of protection than alloys containing more electronegative elements. Roughening of the surface before a protective layer is applied may have an important effect on the stability of the surface; sandblasting and pickling with NaOH reduce the resistance of the surface the most. Passivation of the metal, in particular anodic oxidation (eloxal process) is preferable. Various methods to produce durable oxide layers and their treatment to increase protective action are described. Ha (8e)

1

Aluminum coated Iron- and Steel Sheets a New Building Material (Mit Aluminium plattiertes Eisen- bezw. Stahlblech, ein neuer Werkstoff). M. U. SCHOOP. *Der Bautenschutz*, Vol. 5, Jan. 1934, pages 14-15. Al is sprayed on to the iron and steel sheets by means of an electric metal-spraying pistol. Heating to 650°-700°C. results in a layer of Al-Fe alloy which produced firm adherence between the Al coating and the Fe. Field of application and plating process are dealt with. Kz (8e)

2

A Rapid Test of Thickness of Tin Coatings on Steel. S. G. CLARKE. *Technical Publication, International Tin Research and Development Council*, Series A, No. 12, 1934, 4 pages; *The Analyst*, Vol. 59, Aug. 1934, pages 525-528. Stripping of Sn by immersion for one minute after evolution of gas has ceased, in a solution of 20 gr. Sb_2O_3 in 1 liter cold HCl, sp. gr. 1.146 was found satisfactory. Weight losses run about 1 oz. per base box of tin plate higher than the weight of Sn as shown by chemical analysis, and such a correction is applied. With electrolytic coatings only about ¼ as much correction is necessary. Evidently both the Sn and the $FeSn_2$ alloy of the coating are removed. Except for cast iron, which showed slight attack, the ferrous base metal is not attacked. Detailed instructions, including those for stripping a selected area by stopping off with special varnish, are given. AHE + HWG (8e)

3

Corrosion and Hot Galvanizing of Iron and Steel. ALLAN B. DOVE. *Wire & Wire Products*, Vol. 9, Sept. 1934, pages 298-302, 350. Theory and practice of galvanizing of wire are discussed with particular consideration of the mechanism of corrosion. Chemical reactions occurring during pickling and galvanizing and their influence on corrosion are described. 7 references. Ha (8e)

4

25 Years of the Metal Spraying Process (25 Jahre Metallspritzverfahren). C. H. DAESCHLE. *Chemiker-Zeitung*, Vol. 58, Apr. 18, 1934, pages 317-318. The Schoop metal-spraying process and its two important applications are discussed. 1. a decorative and protective coating, 2. the production of thin metallic shapes by spraying on forms and removal of the film. Zn is the most important metal used for spraying. CEM (8e)

Nickel Plating of Aluminium (Le nickelage de l'aluminium). M. BALLY. *Revue de l'Aluminium et de ses applications* No. 60, Mar.-Apr. 1934, pages 2365-2370. Pickling of the aluminium surface is accomplished best with a boiling solution containing per liter, 6 to 22g of iron and 0.10 to 0.70 mols of HCl. Technique of cleaning, pickling and plating is described in detail. The nickel coating is very sound and is perfectly adherent to the basis metal. AH (8e)

Non-Metallic Coatings (8f)

An English Discussion on Paint as a Metal Preservative (Eine englische Erörterung über Farbe als Metallschutz). *Farbe & Lack*, Feb. 14, 1934, pages 77-79. The papers of Jordan, Bond, Withby, Morgan, Downie, New, Barker, Haygarth before the joint meeting of the Oil & Colour Chemists' Association and the Chemical Engineering Group of the Society of Chemical Industry, London, are summarized. The success of red lead as a pigment on ferrous materials is ascribed to a mild passivating effect. Chromates under certain conditions of exposure act similarly. Zn dust owes its success to inhibition by sacrifice, i.e. it is anodic to Fe. Application of a Zn or Al-pigmented priming coat to Mg alloys accelerates the attack, since the pigment is cathodic to Mg. Chromates which tend to passivate the metal are considered the most useful pigment for such alloys. A thin film of elemental Se was more successful against sea-water spray than any paint investigated. An additional mechanical protection conferred by paints was established. The usefulness of derusting means appears questionable. In a number of cases corrosion even more severe than the normal was noticed after the utilization of such means. The original paper contains a wealth of detail. EF (8f)

6

Rust Protective and Water Proof Paint Coatings (Rostschützende und wasserbeständige Grundanstriche). PAUL L. LOTZ. *Farbe & Lack*, Jan. 24, 1934, page 42. Rust inhibiting pigments + linseed oil successfully protected Fe and steel constructions against atmospheric corrosion but failed in under-water service. Insufficient drying, several weeks, being required, was blamed as the cause of failure. Addition of pulverized litharge (1-2 lbs./gallon paint) cut down the drying period and improved the water resistance of the coating by the formation of Pb soaps. The underlying chemical reactions are discussed. EF (8f)

7

Methods and Apparatus for De-Enameling. C. S. HOUPT. *Enamelist*, Vol. 11, June 1934, pages 11-12. In order to reduce metal losses when, for some reason, enameled pieces have to be de-enameled, a bath of hydroxides has been developed which dissolves the enamel in comparatively short time without injury to the metal base. The equipment which is patented is briefly described, no patent number is mentioned. Ha (8f)

8

Metal Coloring (Metallfärbung). A. BRESSER. *Korrosion und Metallschutz*, Vol. 10, July 1934, pages 169-170. A number of approved chemical and electrochemical methods for coloring Cu, Zn, Sn, Al, Fe, Ag, Au and Ni and their application are described in detail. Ha (8f)

Commercial Aspects of Chlorinated Rubber. *Synthetic & Applied Finishes*, Vol. 5, July 1934, pages 83-84. The pros and cons of this corrosion resistant material widely known under the name of Tornesit are discussed critically. For coating steel pipes against corrosion, chlorinated rubber is advantageous as it gives a harder finish than is the case with oil lacquers. All Fe and steel articles must be thoroughly pickled in HCl and then washed in alkali before applying the rubber paint. The paint is suitably prepared by solution of the chlorinated rubber in one of the many organic solvents in which it is soluble, a 30% solution being typical. Its value as an electrical insulator offers an outlet for plastics in the electrical industry. The latest improvements in manufacture of chlorinated rubber are summarized. EF (8f)

9

New Phosphate Coating Process Developed in U. S. A. *Synthetic & Applied Finishes*, Vol. 5, June 1934, pages 59-66. Heretofore, phosphate coatings have been largely Fe phosphates. The American Chemical Paint Co. has recently developed a method of coating steel with tri-zinc phosphate deposited by electrolytic means. The coating is .0005" thick, impervious to moisture and constitutes a rust-proof primer for paint, enamel or lacquer. The process designated as "granodizing" is described at length. Although applied principally in the treatment of steel, a somewhat similar process, which does not involve electrolytic action and which makes use of a different solution (Zn phosphate) is utilized for Zn-alloy die castings and surfaces coated with Zn or Cd. Costs for immersion treatment of Zn and Cd surfaces are less than 20 cents/100 ft.² and for the electrolytic coating less than 25 cents/100 ft.² of surface treated. EF (8f)

10

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TESTING (9)

The Central Research Department of the United Steel Companies. *Engineer*, Vol. 158, July 6 1934, pages 9-10. Gives description and illustrations of laboratory situated at Stockbridge, near Sheffield, England. LFM (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

Possible Causes for Bearing Failure. C. H. LEIS. *Product Engineering*, Vol. 5, Oct. 1934, pages 377-378. Failures may be due to incorrect oil grooves, thrust washers, friction, chemical reactions, permanent distortion due to excessive forces, or cracking; each cause is briefly discussed. Ha (9a)

Supervision of Die Casting Shops (Die prüftechnische Überwachung im Spritzgussbetrieb). *Die Metallbörse*, Vol. 24, Apr. 21, 1934, page 503. Utilization of highly pure metals for die casting work is stressed; 0.01% Sn, Pb, or Cd cuts down considerably the corrosion resistance of Zn die castings. Several hundredths of a % of Fe are harmless, 0.1% Mg is favorable and counteracts the detrimental effect of Sn, Pb and Cd. Al of 99.5% purity is essential to successful die casting work. The maximum content of Fe in Silumin (Al-Si alloy with 12% Si) should not exceed 0.8%. Fe causes coarse grain and a drop in strength and toughness. Overheating of the alloy must be avoided and the use of thermocuples is indispensable. A weight test usually reveals unsound castings and bending tests should be made regularly. Heating of brass press castings causes the air in the blowholes to expand and blisters show up on the surface of the casting. X-raying of Al and Cu alloys is highly recommended. EF (9a)

Origin of Fractures in Water-Cooled Piston Rods of Diesel Engines (Zur Entstehung der Brüche an wassergekühlten Kolbenstangen von Dieselmotoren). K. DAEVES, E. KAMP & K. HOLTHAUS. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 8, 1934, pages 1065-1067. Investigations on sound and fractured piston rods have shown that fatigue fractures are mainly due to corrosion occasioned by non-metallic deposits from the cooling water. As long as this deposit forms only a thin layer it is perfectly dense and protects from further corrosion. When it becomes thicker it is not flexible enough and is broken by the vibrations giving access to renewed attack by the water. Material for water-cooled piston rods should, therefore, be selected with particular consideration of resistance to water corrosion and, above all, the cooling water should be treated so that attack is reduced to a minimum. 6 references. Ha (9a)

Photoelectric Measurement of the Diameter of Fine Wires (Die lichtelektrische Messung des Durchmessers feiner Drähte). RICH. C. SCHMID. *Elektrotechnische Zeitschrift*, Vol. 55, Aug. 9, 1934, pages 785-786. Bare and insulated wires of from 0.02 to 0.5 mm. are measured continually by letting them pass before a definite, rectangular surface of a photocell. The shadow of the wire cuts off a certain amount of the light thrown on the cell which, as the width of the surface is constant, is proportional to the diameter of the wire. If the cell circuit is adjusted so that the current without a shadow is compensated, then the deflection of a galvanometer will indicate the diam. of a wire when its shadow falls on the surface. The practical application as recording micrometer is described. Ha (9a)

Letting Vacuum Do the Inspection. CHAS. O. HERB. *Machinery*, N. Y., Vol. 40, Aug. 1934, pages 705-708. To determine size of holes of less than 1/32 in. diam. a vacuum inspection instrument is used which allows air to pass through the hole to be inspected and to act on top of a water column in a graduated glass tube. Differences in the height of the water column indicate differences in hole sizes. The method is illustrated by the inspection of carburetors. Ha (9a)

Internal Factory Inspection. F. LAWRENCE. *Inspection*, Vol. 5, July 1934, pages 2-30. Incl. discussion. Paper read before the Institution of Engineering Inspection Jan. 11. 1934. Deals with the inspection of raw materials and purchased finished parts and the inspection of parts in various stages of manufacture. Kz (9a)

Gages for Final Inspection. F. HARTLEY. *American Machinist*, Vol. 78 Sept. 12, 1934, pages 642-643. Proper use of master inspection gages and set-ups for checking several successive operations in mass production are discussed. Ha (9a)

66 Causes of Defects in Finished Steel Parts. W. H. C. BERG & ST. P. ROCKWELL. *Product Engineering*, Vol. 5, Oct. 1934, pages 382-383. Possible defects in steel parts and methods to examine them for the cause are classified in a table. Ha (9a)

Detection of Internal Stresses by X-rays (Über den Nachweis innerer Spannungen mit Hilfe von Röntgenstrahlen). FRANZ WEVER & HERMANN MÖLLER. *Die Naturwissenschaften*, Vol 22. June 1, 1934, pages 401-403. Stresses in Fe can be determined by X-rays with an accuracy of $\pm$ 2 kg./mm.^{2} For this purpose the lattice constants must be determined with an accuracy of 0.0001 A.U. The lattice constant changes of an open hearth steel due to stresses up to 36 kg./mm.^{2} and the uneven stress distribution in a bent bar under tension are disclosed by X-ray tests. These show that steel is able locally to endure elastic stresses which go far beyond the ordinary yield point. Further test data gained by mechanical and X-ray determinations show the quenching stresses in a steel shaft water-quenched from 650° C. as compared with a slowly cooled shaft. A comparison between both testing methods shows that only the X-ray determination furnishes absolute values. Owing to the reduced exposure times realized by the latest X-ray equipment, the utilization of internal stress measurements by X-rays in shop work is feasible. EF (9a)

Non-Destructive Methods of Testing Welded Joints. C. E. WEBB & L. H. FORD. *Iron & Coal Trades Review*, Vol. 129, July 27, 1934. pages 130-131. The second report of the (British) Steel Structures Research Committee reviews methods of non-destructive testing of welded joints. X-ray examination was excluded as a commercial, routine test because of cost and difficulty of securing mobility of apparatus and safety for operators. Use of gamma-rays obviates some of the difficulties but detection of flaws in the direction parallel to the main plate is difficult. Magnetic and electric methods using search coils or measuring voltage differences give good results; the different procedures employed in these tests are described. Ha (9a)

Older Non-Destructive Tests Should Not Be Abandoned for Radiography. *Industrial Standardization*, Vol. 5, March 1934, pages 56-57. Abstract of an article in *Engineer*. Among other nondestructive tests are hydraulic testing of pressure vessels, various electrical methods, and deflection under load. AHE (9a)

X-Ray Technique for Weld Examination. *Mechanical World & Engineering Record*, Vol. 95, June 22, 1934, pages 602-603. Description of the Philips outfit for taking X-ray photographs of welds. The mechanical efficiency of X-ray photography is extremely low. It is said that of the electric energy entering the tube only 0.2% is converted into X-rays, and even then only 1% of that which reaches the film is absorbed by it. Intensifying screens containing calcium tungstate are used, reducing exposure time to about 1/8 of what it would be otherwise. Radiographic technique is described. Kz (9a)

Radiographic Detection of Intercrystalline Corrosion in Wire Ropes (Röntgendurchstrahlung von Drahtseilen zum Nachweis innerer Korrosion). *Die Naturwissenschaften*, Vol. 21, Dec. 1, 1933, pages 853-854. The differing absorption of X-rays due to the roundness of cables is eliminated by placing the work into a 70% $SnCl_2$ solution. A uniformly exposed radiogram will be secured due to the absorbing action of the solution. Previous to this inspection, which should be repeated under 3 different angles, the test piece is dipped into paraffin in order to exclude corrosion attack. Exposure for 28 mm. diam. rope was 15 min. with 120.000 volts and 5 m.a. EF (9a)

X-Ray Inspection of Welded Boiler (Roentgenonderzoek van een gelaschten Ketel). H. I. Da Costa. *De Ingenieur*, Vol. 49, June 15, 1934, pages E93-E94. The welded seams of a boiler for 22 atmospheres pressure with a wall thickness of 30 mm. were inspected by X-rays; 147,000 volts proved to be the best as with higher voltage contrasts were dimmed, and for lower voltages times of exposures became too long. Photographs of seams are shown. Ha (9a)

Non-Destructive Methods of Testing Welds. J. W. Donaldson. *Sheet Metal Industries*, Vol. 8, May 1934, pages 311-312; June 1934, page 367. See *Metals & Alloys*, Vol. 5, July 1934, page MA 344. AWM (9a)

X-Rays in the Service of Metallurgy (Roentgenstrahlen im Dienste der Metallforschung). E. Schiebold. *Die Giesserei*, Vol. 21, July 20, 1934, pages 309-310. General discussion of use of X-rays in structural investigations, practical applications for determining quality and soundness of castings, welds, etc., and equipment available for routine measurements. Ha (9a)

Radiographic Control of Welds (Le Controle Radiographique des Soudures). Robert Schmidt. *La Technique Moderne*, Vol. 26, June 15, 1934, pages 429-432. First describes means of interpretation of radiograms. It is shown that with 2 positions of the X-ray tube it is possible to use the stereoscopic method to know the position of a defect inside of the thickness of the weld. It is also possible to learn the thickness of a defect from the density of its image on the film. In the last section, requirements to be met by industrial radiographic appliances are reviewed and the author concludes that the new control technique is without danger or difficulty and that the method is accurate. FR (9a)

Examination of Metallic Articles by Means of X-rays and Gamma Rays (L'examen des pieces metalliques par les rayons X et par le rayons gamma). *Genie Civil*, Vol. 105, July 1934, pages 65-66. See "Status and Development of Material Testing without Destruction," *Metals & Alloys*, Vol. 5, June 1934, page MA 274. JDG (9a)

Improvements in Rail Fissure Detection. *Railway Engineer*, Vol. 55, July 1934, pages 227-228. A discussion of the recent improvements in the Sperry detector, particularly the searching unit and recording. The improvements resulted in an increased number of detected rail defects. WH (9a)

Physical & Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

Influence of Shape of Test Specimen on the Tensile Strength of Materials and Weld Joints with Regard to Elongation of Rupture and Hardness (Der Einfluss der Stabform auf die Zugfestigkeit von Werkstoffen und Schweiss verbindungen unter Berücksichtigung der Bruchdehnung und der Härte). A. Matting & H. Koch. *Die Elektroschweissung*, Vol. 5, July 1934, pages 127-134. Authors summarize results of experiments on the suitability of different sample shapes for judging welding properties carried out at welding Experimental Station of Deutsche Reichsbahn, Wittenberge. The mechanical properties of test samples of 3 different brands of steels St. 34, St. 37 and St. 52 and of welded samples of these steels, (1) arc welded with coated electrodes, (2) arc welded with non-coated electrodes, (3) gas fusion welded, were determined. GN (9b)

Method for Showing Hardness Variations on a Steel Surface (Ein Verfahren zur Sichtbarmachung von Harteunterschieden auf einer Stahloberfläche). C. Benedicks & C. F. Mets. *Arkiv för Matematik, Astronomi och Fysik*, Vol. 24A, No. 15, 1934, 14 pages. See *Metals & Alloys*, Vol. 5, June 1934, page MA 277. EF (9b)

Freezing Point of Rhodium. Wm. F. Roeser & H. T. Wensel. *Bureau of Standards Journal of Research*, Vol. 12, May 1934, pages 519-526. Freezing point of Rh was determined by measurements with a disappearing filament type of optical pyrometer by measuring the ratio of brightness of black bodies immersed in freezing Au and freezing Rh. The Rh was melted and frozen in vacuo to prevent the absorption gases during melting. Attempts to operate with the Rh in atmospheres of air and of N were not successful. The ratio of brightness of black bodies at the freezing points of Au and Rh was found to be 751 for wave length 0.6527μ. This gives 1966° C. for the temperature of freezing Rh when the Au point is fixed at 1063° C. and C_2 at 1.432 cm-degrees. The value 1966° C. is probably accurate to $\pm$ 3° C. WAT (9b)

Thermal Expansion of Artificial Graphite and Carbon. Peter Hidnert. *Bureau of Standards Journal of Research*, Vol. 13, July, 1934, pages 37-51. The linear thermal expansion of longitudinal sections and of transverse sections of 1" artificial graphite electrodes were investigated temperatures between 20 and 1000° C. The coefficient of expansion for the transverse sections are larger than the coefficient of expansion for the longitudinal sections. The linear expansion of two types of C which are used for expansion elements in temperature regulators for gas ovens were investigated between temperatures 20 and 350° C. The coefficient of expansion of C made with lampblack is about 3 times as large as the coefficients of C made with petroleum coke. WAT (9b)

Application of the Hertz's Theory of Impact to the Longitudinal Vibration of a Bar excited by the Impact of an Elastic Load. M. Ghosh. *Zeitschrift für angewandte Mathematik & Mechanik*, Vol. 14, Apr. 1934, pages 71-76. In English. Summary in German. The theory of Boussinesq concerning the longitudinal vibrations of a bar struck by a severe blow is extended to the more general case of an elastic load in the light of the Hertz theory of impact. It is assumed that the Hertz law of compression is obeyed during the beginning and end of the contact whereas the Hooke law holds in the meantime. It has been found that the duration of the phenomenon depends on the velocity of the impact and on the wave produced in the test bar. This interprets the propagation of the pressure during contact which fact has been photographically established in 2 Cu bars by Tschudi. WH (9b)

International Standardization of the Small Notch-Impact Test (Zur internationalen Normung der kleinen Kerbschlagprobe). J. Dannenberg. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 1, 1934, pages 1045-1046. While the large notch-impact test has been standardized internationally with specimens of 30 x 30 x 160 mm. (Charpy specimen), and 4 mm. round notch and 15 mm. deep notch, no agreement has been reached yet for a small size specimen. Several new suggestions are discussed and results compared. Tests made by Steccanella favor a standardizaiion of a specimen of 10 x 10 x 55 mm. with 2 mm. depth of notch and 1 mm. notch radius. Ha (9b)

Wear resistance steels and Wear Tests (Aciers résistant à l'usure et essais d'usure). Pierre Benloz. *Métaux*, (formerly *Aciers Speciaux, Métaux et Alliages*), Vol. 9, Feb. 1934, pages 36-46. A critical survey of wear tests. 14 references. GIM (9b)

New Method of Testing Elastically Loaded Metal Parts (Ein neues Verfahren zur Prüfung elastisch beanspruchter Metallteile). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 1, 1934, page 410. The paper briefly describes the method recently developed by Portevin and Cymboliste. In this method the part to be tested is coated with a lacquer that adheres so tightly that it undergoes all deformations to which the part is subjected, but which, on the other hand, is so brittle that it is destroyed before the elastic limit is reached. Fine cracks are then developed that indicate the course that fatigue cracks would take in the metal part. The adhereability of the lacquer depends on the preparation of the metal surface, the composition and the drying method of the lacquer. GN (9b)

Rockwell-Brinell Conversion Tables. *Machinery*, N. Y., Vol. 41, Sept. 1934, pages 35-36. Complete conversion tables between Brinell numbers, 500 and 1000 kg. load, and Rockwell scales B, F, G, 15-T, 30-T and 45-T, from Rockwell B100 to 0, and from Rockwell C65 to C20, are given. Ha (9b)

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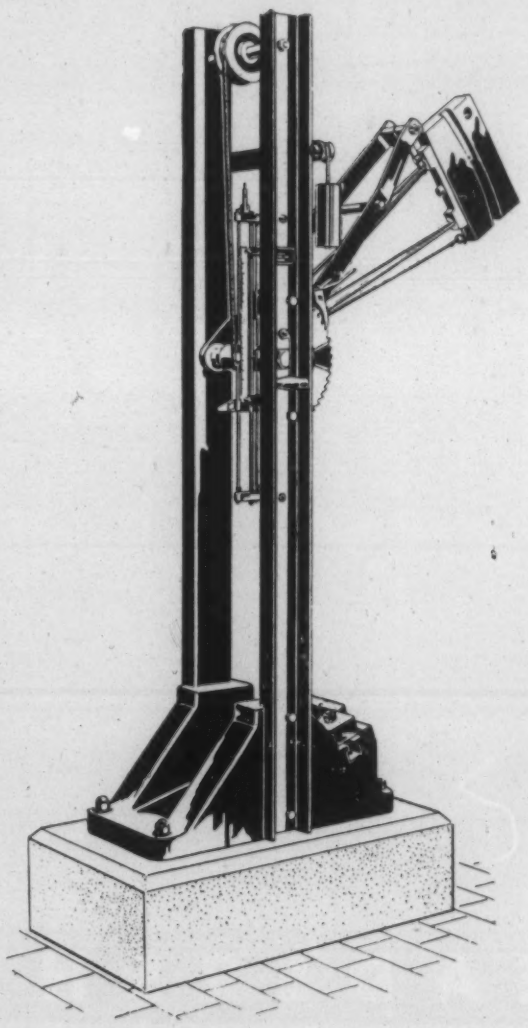

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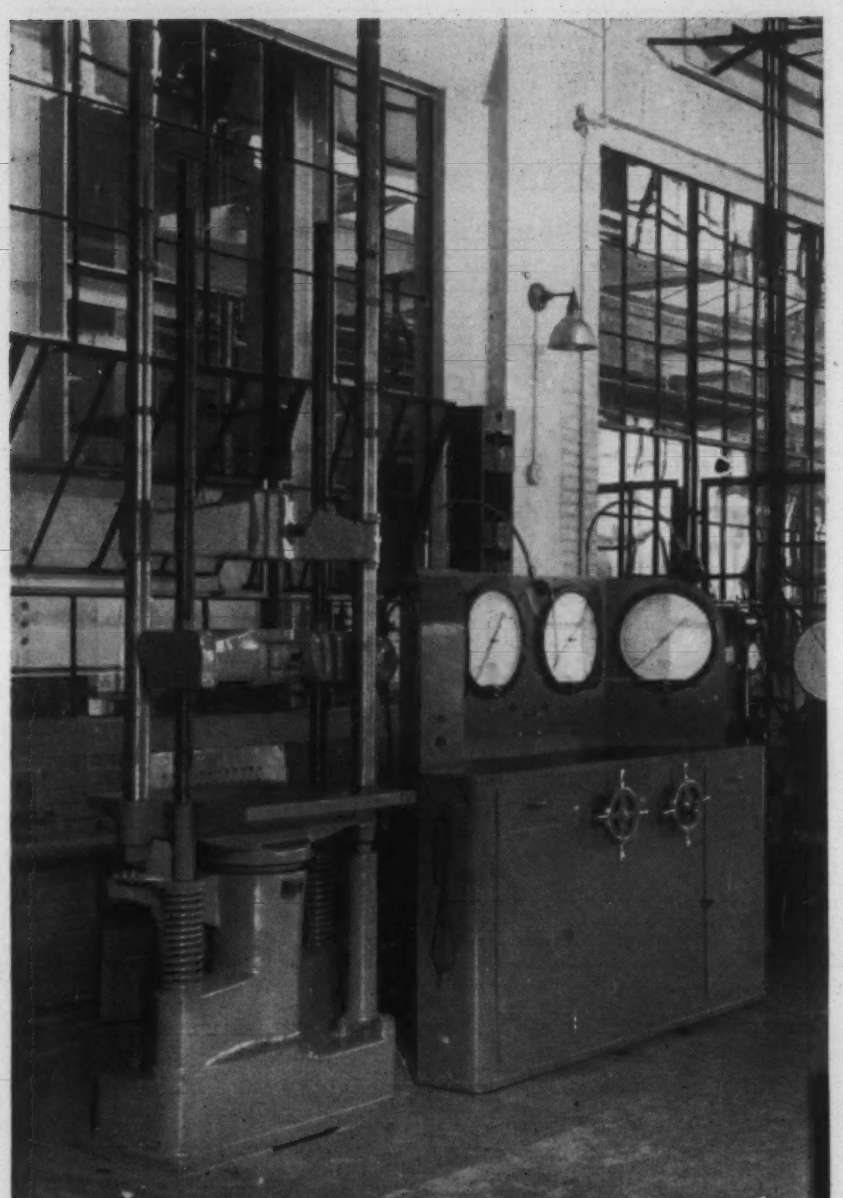

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A Three-Ton Testing Machine. JOHN L. M. MORRISON. *Engineer*, Vol. 157, June 22, 1934, pages 626-627. Describes machine provided with an autographic recorder for tension tests. Machine is especially valuable in giving diagrams suitable for teaching purposes. It is possible to demonstrate graphically the results of pauses in loading, of different heat treatments before or after overstrain, or the characteristics of ductile and brittle materials. Machine can also be altered to allow compression diagrams to be made. Tables and diagrams are given showing actual results of tests made on the machine. LFM (9b)

Method for Determining Torsional Stress by Means of a Diaphragm Model (Verfahren zur Ermittlung der Torsionsbeanspruchung mittels Membranmodell). E. KOPF & E. WEBER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, July 28, 1934, pages 913-914. The method described utilizes a thin membrane (rubber, etc.) which is expanded over a horizontal plate in which an opening is cut of the same shape as the section to be investigated. If a pressure difference exists on both sides of the membrane the latter bulges to one side; this deformation is fixed by a plastic mass cast on one side (paraffin, etc.). According to the theory of Prandtl the deformation corresponds at any point to the trajectories of the shearing stress; the tangent of the angle of inclination is proportional to the principal shearing stress at this point. The practical application by turning thin layers of the plastic mass and the evaluation is described. Ha (9b)

Elastic Strength. J. B. KOMMERS *Engineering*, Vol. 137, June 22, 1934, pages 695-697; June 29, 1934, pages 737-738. Discusses methods used in testing and gives results obtained in determining elastic limit of steel and brass. For steel, results show that the tedious and expensive method of determining the elastic limit is not necessary as proportional limit closely approximates the value for elastic limit. Results on brass show that there are other objections to the method of measuring elasticity by means of elastic limit since the value may be influenced by the repeated loadings used in making the test. For wrought ferrous materials the yield point is probably satisfactory as a measure of elastic strength. Tables are given showing results of these tests. See also letters commenting on this paper in *Engineering*, Vol. 138, July 6, 1934, page 20 and Aug. 3, 1934, pages 114-115. LFM (9b)

Suggestion for a New Method for the Detection and Approximate Determination of Interior (Proper) Stresses (Vorschlag zu einem neuen Verfahren zur Festellung und angenäherten Ermittlung von Eigenspannungen). F. HOENIG. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 82, June 25, 1934, pages 70-72. Interior stresses can be detected by the difference in the forces which are required to produce an initial permanent deformation on a spot where no interior stress exists and at the place where such stress is present. The magnitude of the difference can be used for determining the magnitude of the interior stress. The practical application of a measurement on this basis is explained. Ha (9b)

Fatigue Testing (9c)

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in co-operation with the A.S.T.M. Research Committee on Fatigue of Metals.

Experiments on the Rolling Abrasion of Carbon Steels. TOSIO NISHIHARA & TOSIRÔ KOBAYASI. *Journal Society of Mechanical Engineers*, Vol. 37, Apr. 1934, pages 187-196. In Japanese. Paper read before Western Division of the Society of Mechanical Engineers, July 8, 1933. Experiments were carried out with C steels containing 0.07-0.77%C to determine the relation between the pressure and the wear on the rolling contact without lubricant. For the low and medium C steels the wear loss increases above the contact pressure of 50-60 kg. at 10% slip. Higher C steels do not show that character. This critical pressure is considerably affected by the amount of slip, the greater slip giving the lower critical pressure. Scarcely any relation is found between the critical point of abrasion and the mechanical work expended to the wear, the work hardening of the surface or the rise in temperature of the specimen due to friction, but there is a conspicuous difference between the worn surfaces below and above the critical point. It seems that the abrasion above the critical point takes place by destruction owing to the fatigue of the metal surface, and this critical point may be considered as a fatigue limit of abrasion. Kz (9c)

The Effect of Oil and Water on the Fatigue Limit of Steel. AKIMASA ONO. *Journal of the Society of Mechanical Engineers*, Vol. 37, Jan. 1934, pages 8-10. (In Japanese). Paper read before the Meeting of the Society of Mechanical Engineers, Nov. 25, 1933. Deals mainly with the effect of oil on the fatigue limit. The tests were carried out in a fatigue testing machine of the rotating beam type. It was found that test pieces subjected to jets of oil endure stress as well as, or even better than test pieces under ordinary conditions. Kz (9c)

On the Change of Mechanical Properties in Metals under Repeated Stress and Recovery of Fatigue. RYÔNOSUKÉ YAMADA & YÇZÔ MATSUOKA. *Journal of the Society of Mechanical Engineers*, Vol. 37, May 1934, pages 273-281. (In Japanese). Paper read before the Extraordinary General Meeting of the Society of Mechanical Engineers at Ôsaka, Nov. 3, 1933. When experiments are carried out under stresses exceeding a certain limit, work-hardening takes place in early stages of the repetition of stress. In the next stage the growth of minute cracks will be noticed, resulting in the decrease of hardness. Test pieces were heated above recrystallization temperature in a vacuum after suffering certain numbers of repetitions, and then again subjected to repeated stress, the magnitude being equal to that before heating. Test results show that there are two stages in the course of fatigue, one being the hardening stage and the other the crack-growing stage. In the former stage metals can be made to recover by suitable annealing but not in the latter one. Kz (9c)

Models Reveal Changes Needed to Combat Fatigue. R. L. SCORAH. *Machine Design*, Vol. 5, Nov. 1933, pages 31-33. The effective stress concentration factor for shouldered shafts under repeated stress is studied by comparing the endurance limit for a shaft with a shoulder with that of a standard fatigue specimen of the same minimum diameter and with a fillet of 9.85 inches radius at the reduced section. For small specimens of SAE 3325 steel, heat-treated, the following table indicates the effective stress-concentration factors obtained. D is the large diameter of shaft at the shoulder, d is the small diameter of shaft at the shoulder, and r is the radius of fillet at the shoulder,—all in inches.

d in.	D/d	Stress-concentration Factor $r/d = 0.25$	0.19	0.12	0.06	0.01
0.3	1.2	1.50	1.60	1.85	1.95	2.20
0.3	1.4	1.62	1.72	2.06	2.20	2.48
0.3	1.6	1.70	1.82	2.15	2.34	2.70
0.3	1.8	1.74	1.92	2.24	2.45	2.92
0.3	2.0	1.76	1.98	2.30	2.60	3.10

Specimens of heat-treated SAE 1045 steel showed stress-concentration factors about 77 per cent of those for the SAE 3325 steel, and specimens of heat-treated SAE 1025 steel showed stress-concentration factors about 85% of those for the SAE 3325 steel. Some interesting stress concentrations were developed in special tests of shafting specimens with grooves near the shoulder in the large part of the shaft, with shaft specimens with radial holes, and with shaft specimens with longitudinal keyways. WH + HFM (9c)

Some Aspects of the Fatigue Properties of Patented Steel Wire. E. T. GILL & R. GOODACRE. *Iron & Steel Institute, Advance Copy* No. 3, Sept. 1934, 25 pages. Endurance properties of patented wires were obtained with a Haigh-Robertson machine. In this machine a length of wire is bowed by end thrust and rotated by chucking one end in the shaft of a motor. The customary speed of the machine is 14,000 stress cycles per min. Wires containing 0.36, 0.46, 0.55, and 0.79% C were tested. Some were patented in Pb and some in air. Some had decarburized skin removed after patenting and others were tested with decarburized layer present. Others were polished with emery. All wires were drawn to a diameter of 0.080 in, but for each C-content wires of cold reduction between 0 and 90% were tested. For the wires with decarburized skin C had no influence on endurance limit. For wires not decarburized endurance limit increased with C content but not in proportion to tensile strength. For wires with decarburized surface endurance limit increased with degree of reduction to a reduction of 75 or 80% and then decreased slightly. With other wires the endurance limit increased steadily as the degree of reduction increased. It is suggested that the endurance properties at stresses above the endurance limit are important for wire. There is no apparent connection between any property of patented wire and endurance limit unless it be with the behavior in reverse-bend test. 15 references. JLG (9c)

Fatigue Tests on Hard Drawn Steel Wire. JOHN J. DOWLING, S. M. DIXON & M. A. HOGAN. *Engineer*, Vol. 157, Apr. 27, 1934, pages 424-426. The test method consists of supporting the specimen as a "free free" bar in a magnetic field and causing it to vibrate by passing through it a pulsating electric current of resonant frequency. When vibration occurs, the specimen is subjected to bending stresses alternating from a positive to a negative maximum value. This stresses the material in tension and compression alternately. The specimen does not rotate so the maximum stresses on any cross section will be in one diameter, in the plane of vibration. Thus the maximum stress will only operate on two lines on opposite sides of the wire. The tests were limited to wires of 0.05 in. to 0.135 in. diameter. The length of the wires vibrating at 100 periods per sec. varied from 10.5 in. to 15.3 in. Tests on plough acid wire showed that the stress limit decreases with increase in the number of reversals, rapidly at first and then decreasing and becoming constant at one million reversals. The value of fatigue limit in reversed bending is about 1/4 the tensile strength or the fatigue range is about 1/2 the tensile strength. (Note by HFM: The ratio of 1/4 seems lower than that for softer and weaker steels. This is in line with test results by Lessells and others). On new wire the fatigue range in reversed bending is about ½ the tensile strength of the wire. Results for special acid quality were better than for acid quality in extra special plough grade, worse for plough grade wire but showed no difference between two qualities in the special plough grade. Some preliminary experiments were carried out on fatigue resistance of wire exposed to corrosion in a spray of tap water. Tests were made to show effect of heating wires on fatigue resistance. Heating up to 600°C. produced marked reduction in fatigue resistance which was relatively less than the reduction in tensile strength. One series of tests at 450°C. showed that the tensile strength was reduced about 16% while the fatigue resistance was only just affected. LFM (9c)

Endurance of Specimens with Keyways and the Improvement in Endurance from Working the Surface (Die Biegewechselfestigkeit genuteter Stäbe und die Erhohung der Dauerhaltbarkeit durch das Oberflächendrücken). H. WIECKER. *Mitteilungen des Wöhler-Instituts*, No. 19, 1934, 52 pages. Comparative endurance tests were made on rotary beam specimens bearing keyways, in which the stress was raised stepwise every 2 million cycles. The reduction in endurance due to the keyway used in an ordinary machinery steel was about 45%. Chamfering off the sharp edges of the keyway reduced this loss to about 40%. Cold working of the junction between bottom and sides of the keyway with a small tool driven by an air hammer produced a similar small reduction in the loss. While this change in stress endured was not large, the life under a given stress was often increased 10 times. Attempts to cold work the corners of the keyway by mechanical means were not successful. Improvement in the hand-worked specimens was about the same for machinery steel and for hard heat-treated steel but the hammering technique improved with experience so that the softer steels tested earlier in the study may not have been given the most effective working. The tests on each individual specimen studied are described in considerable detail. HWG (9c)

Fatigue of Metals (La Fatigue des Métaux). R. CAZAUD. *Usine*, Vol. 43, July 5, 1934, page 37. Results of investigations by the (French) Aeronautic Research Institute are given in brief. The fracture of a piece broken by fatigue shows 2 characteristic views: a smooth circumferential zone and a central zone with more or less distinct veins or grains. The fracture originates in a minute crack (metallic inclusion) extending progressively along the lines of least resistance (from one inclusion to another). The smooth appearance is due to prolonged rubbing of the borders of the crack; the grainy zone corresponds to the sudden rupture. Test methods are described. C steels (ferrite-pearlite) have a fatigue limit of 26-32 kg./mm.², which goes up to 44 for martensitic, semi-hard steels, tempered; Ni-Cr-Mo, Ni-Mo and Cr-Mo steels, hardened and tempered have a limit up to 65 kg./mm.²; tempering at 600° C. gives good results (homogeneous osmondite). Among light-metals, Mg alloys are equal to duralumin with 12 kg./mm.² and superior to Al with 4-7 kg./mm.² Ha (9c)

Effect of Pre-stressing upon Endurance Strength (Invloed van de voorspanning op de vermoiingsvastheid). *Polytechnisch Weekblad*, Vol. 29, Mar. 15, 1934, page 174. Based on endurance bending and torsion tests, the interrelation between maximum fatigue bending strength σ_O at a prestress of σ_V and the ordinary endurance bending strength σ_W is covered by the formula according to Ludwig & Krystof

$$\sigma_O = \sigma_W + \alpha\sigma_V$$

where $\alpha \leq 1$. An analogous equation holds for the fatigue torsion tests on material submitted to pre-stressing. Endurance tests with notched Cr-Ni steel prestressed to a varying extent yielded a decreasing sensitivity against grooving with increasing torsional loads but in the case of bending tests the marked effect of notching was apparent even if considerable prestresses had been applied. Corrosion endurance strength in sea-water could not be raised by heat-treating. In the case of medium pre-stresses practically no difference between soft and hard steels could be observed. Below the yield point the gain of endurance strength was proportional to the amount of pre-stressing in torsional and bending tests with all testing materials whether they were grooved, polished or corroded. WH (5c)

Fatigue Testing Machine. *Iron & Coal Trades Review*, Vol. 129, Aug. 24, 1934, pages 261. Describes a machine built by Boumens, Ltd. (Musselburgh, England) for electromagnetic fatigue-testing of wire. The length of the test piece is 150× diam. About 2 million cycles are applied for usual wire sizes per 24 hrs. Ha (9c)

Accelerated Cracking of Mild Steel (Boiler Plate) under Repeated Bending. Part II. Further Tests. C. H. M. JENKINS & W. J. WEST. *Iron & Steel Institute, Advance Copy* No. 6, Sept. 1934, 13 pages; *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, pages 371-373. Bars were repeatedly bent in corrosive solutions at ordinary and elevated temperatures and in air at elevated temperatures. The bars were from a steel containing 0.11% C. Increasing the temperature of testing led to a reduction of the number of bends required to produce fracture, but there was no appreciable difference in the number of bends in the experiments at 100°C. if the bending is in air, tap water or caustic soda solution. The conditions of bending were not such as to produce "caustic cracking" in the caustic soda solution. JLG + Ha (9c)

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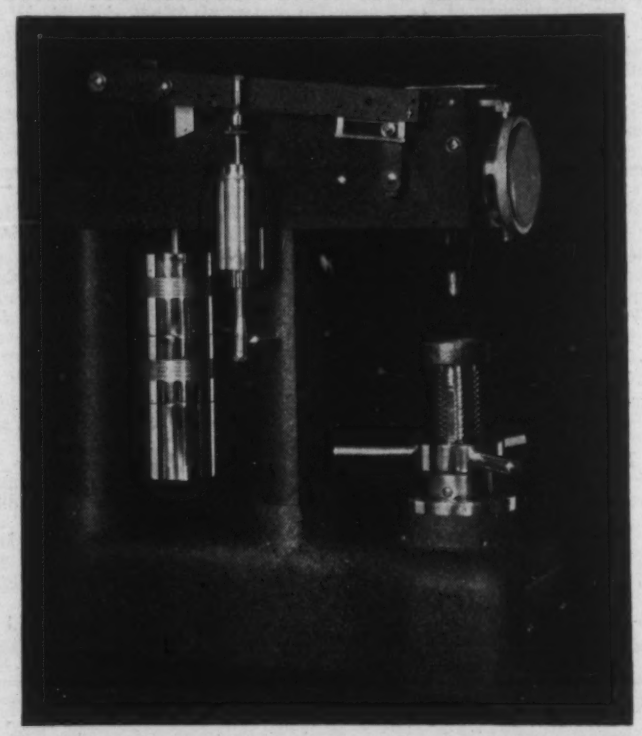

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Magnetic Testing (9d)

L. REID, SECTION EDITOR

Ferromagnetism in Metallic Crystals. L. W. MCKEEHAN. *Metals Technology*, Aug. 1934, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 554, 42 pages. This is the Institute of Metals Division lecture of Feb. 1934. Studies on the ferromagnetism of single crystals are critically reviewed. The directions of easiest magnetization are those of simple crystallographic forms and the extra energy needed for magnetization in other directions depends on the material selected for test. Differences in magnetization seem to be dependent on crystal form rather than on accidental differences in purity or freedom from strain. 55 references. JLG (9d)

Experimental Proof of the Resistance Changes of Thin Metallic Layers by Electric Charging (Experimenteller Nachweis der Widerstandsänderung dünner Metallschichten durch Aufladung). ALEXANDER DEUBNER. *Die Naturwissenschaften*, Vol. 22, Apr. 13, 1934, page 239. The author succeeded in proving experimentally for the first time that the resistance of thin metallic layers varies by adding or taking away electrons. The metallic layers of Ag prepared in vacuum were utilized. Tests on Bi confirmed the experimental results on Ag qualitatively. EF (9d)

Spectrography (9e)

What can the Metallurgist Expect from the Spectrograph? (Was kann der Metallhüttenmann vom Spektrographen erwarten?). W. KROLL. *Metall und Erz*, Vol. 31, May 1934, pages 201-204. The spectrograph and its accessories are described and the fields of usefulness of the spark and arc processes are discussed. The following methods of quantitative analysis are briefly described: Comparison of the intensity of lines in the unknown sample with standards, the use of homologous pair lines, and the logarithmic sector. The fact that no gases and metalloids can be determined is a shortcoming of the spectrograph. Specifications for pure Zn, Pb and Cu are given. It is almost impossible and not practical to determine such small quantities of impurities by regular chemical analysis. The limits of accuracy for the spectrographic determination of impurities in Zn, Pb and Cu are given. They are not good enough for O, Sb, Sn, S, As, Te, and Bi in Cu. The speed and permanent record obtained by the spectrograph are advantageous. It is possible to determine rare metals, such as Ga in Al, Ge in slags, Ga and In in Zn and Pb ores. It is useful for the examination of fractures, by analyzing various sections of a fracture, for the analysis of small samples of corrosion products, and for the quick determination of segregation. The spectrograph should be considered as an aid to chemical analysis, not as replacing it. CEM (9e)

Focusing Methods for Analysis of Crystalline Powders and Spectrography with X-Rays and Gamma Rays (Méthode de Focalisation dans l'Analyse des Poudres Cristallines et dans la Spectrographie des Rayonnements X et γ). H. HULUBEI. *Comptes Rendus*, Vol. 198, June 18, 1934, pages 2164-2166. In a modification of Debeye and Scherrer method of powder analysis, author describes use of curved samples of powder and circular slit and shows improvement in use of back reflection. FHC (9e)

Metals Analyses Simplified. Progress of Non-Ferrous Association. *Chemical Trade Journal & Chemical Engineer*, Vol. 93, July 28, 1933, page 60. Report of Annual meeting of the British Non-Ferrous Metals Research Association held at Birmingham. Among topics considered were new Pb alloys, corrosion of galvanized hot water tanks, spectroscopic analysis, new Cu-Ni alloys, and the casting of Al and Brass. JN (9e)

METALLOGRAPHY (10)

J. S. MARSH, SECTION EDITOR

The Super-microscope Enlarges 14,000 x (Das Übermikroskop vergrössert auf das 14,000 fache). K. LUTZ. *Die Umschau in Wissenschaft und Technik*, Vol. 38, May 13, 1934, pages 389-391. Electron rays which have a wave length of 1/50,000 of ordinary light are utilized by E. Ruska of the Technische Hochschule Berlin in his super-microscope. Electric coils function instead of glass lenses. Images of 14,000 enlargement have been made visible on screens and enlargements of from 20-30,000 x will be realized in the near future. The super-microscope is described in detail and illustrated. WH (10)

An X-Ray Investigation of the Arsenic-Tin System of Alloys. W. H. WILLOTT & E. J. EVANS. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Vol. 18, July 1934, pages 114-128. Results of an investigation by X-rays of the system As-Sn indicate that the phase from 0 to 29.5% As is a solid solution and not a mixture of Sn and Sn_3As_2; no evidenec of the latter compound was found. The compound AsSn has a NaCl structure and extends as homogeneous phase from 34.5 to 49% As. The NaCl structure extends still further to 68% As. The existence of a solid solution of Sn in As is confirmed. There is close resemblance with the Sb-Sn system, both form compounds of the form AB. Solubility of As in Sn is 29.5% while that of Sb is 9%. Solubility of Sn in Sb is 10% while in As it is 32%. 13 references. Ha (10)

Thermal Variations of Demagnetizing Structural Factor in Ni and Co (Variation Thermique du Facteur Démagnétisant Structural dans le Nickel et le Cobalt). THÉODORE KAHAN. *Comptes Rendus*, Vol. 199, July 30, 1934, pages 349-351. Studies made with magnetometer on Ni samples with varying mechanical and thermal treatments. Structural demagnetizing field shown to differ from geometric demagnetizing field. The former decreases with increasing temperature while the latter remains constant. FHC (10)

Equilibrium in the Lead-zinc System with Special Reference to Liquid Solubility. R. K. WARNING, E. A. ANDERSON, R. D. SPRINGER & R. L. WILCOX. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 570, Sept. 1934, 10 pages. The liquid solubility of Pb and Zn was determined by several methods and methods used by earlier workers were investigated in order to determine relative accuracy of different methods. Any method that involves rapid cooling and subsequent analysis of the 2 layers does not yield equilibrium values. Thermal analysis placed the monotectic at 0.7% Pb and 417.8° C. At this temperature the miscibility gap extends from 0.7 to 98% Pb. At 600° C. the gap extends from 6 to 94% Pb. At 700° C. it extends from 15 to 88% Pb. The critical point seems to be at 50% Pb and 790° C. 9 references. JLG (10)

On the Design and Construction of a Precision High Power Metallographic Apparatus. FRANCIS F. LUCAS. *Transactions American Society for Steel Treating*, Vol. 21, Dec. 1933, pages 1112-1135. See "A Precision, High Power Metallographic Apparatus," *Metals & Alloys*, Vol. 5, July 1934, page MA 350. WLC (10)

On Ferromagnetism and the Structure of Fe (II, III) Oxide (Über Ferromagnetismus und Struktur des Eisen (II, III) Oxyds). ALFONS KRAUSE. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 26, June 1934, pages 58-62. A constitution formula, in which peculiar 2-Fe-2-O compounds are assumed, is discussed. EF (10)

Changes of Physical Properties of a Worked Single Crystal during Crystal Recovery (Änderung der Eigenschaften eines deformierten Monokristalls bei der Erholung). M. O. KORNFELD. *Physikalische Zeitschrift der Sowjetunion*, Vol. 5, 1934, pages 185-189. Experiments on single crystals of Al proved that only a partial healing of the lattice of single crystal takes place during crystal recovery. The remaining distortions are characterized by a high degree of stability. A direct connection between initial deformation and yield point could be established. EF (10)

Electrochemical Investigation of Solid Thallium-Bismuth Alloys (Eine elektrochemische Untersuchung von festen Thallium-Wismut Legierungen). ARNE ÖLANDER. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 169, July 1934, pages 260-268. Using a previously developed testing method (See *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 5 L10, Apr. 1934, page MA 156 L6), the potential of the cell $Tl_{solid}|(Na,K,Tl)OCO.CH_3|(Tl,Bi)_{solid}$ and the temperature coefficients are determined for 12 different electrode alloys between 245° and 295° C. and the potentials of the cell $Tl_{solid}|TlOCO.CH_3|(Tl,Bi)_{solid}$ and its temperature coefficient were measured for 32 different alloys between 120° and 165° C. The former diagram has been revised and the existence range of the 2 intermediary phases established precisely. Both phases seem to possess a chaotic atom distribution. The ϵ phase may be considered as Bi_2Tl, but approximately 1/3 of all elementary cells contain misplaced atoms. The loss of free energy, entropy increase and heat change of the Tl-Bi alloys were determined. EF (10)

Effect of Thermal Stresses on Austenite. H. P. NIELSEN & R. L. DOWDELL. *Transactions American Society for Metals*, Vol. 22, Sept. 1934, pages 810-832. In this study, stress distribution has been simplified by use of steel balls and thermal stresses made negligible by slow cooling rates. Conclusions from the study are that thermal stresses are not essential to change of austenite to martensite, that the tensile stresses tend to facilitate the change of austenite to martensite at the temperatures of liquid air the change is initiated by the instability of austenite at that temperature, that the stability of retained austenite is increased with increased quenching temperature and that by quenching severely carburized pure Fe, austenite may be retained at 100° C. even when held. WLC (10)

Review of Recent Structural Determinations Belonging to the Compound Type AB_3 (Übersicht über neue Strukturbestimmungen von Verbindungen AB_3). WERNER NOWACKI. *Zeitschrift für Kristallographie*, Vol. 89, Aug. 1934, pages 85-88. Reviews crystal structures recently determined (1931-34) among which the following ones will interest metallurgists: (1) Idealized WO_3 type: CFe_3, $LaSn_3$, $LaPb_3$, (2) Cu_3Au group: $NaPb_3$, $CaPb_3$, $SrPb_3$, $CePb_3$, $CaTl_3$, $CaSn_3$, $CeSn_3$, $MnNi_3$. (3) Combination trigonal prisms: CFe_3, CCo_3, CMn_3, CNi_3, $AlAg_3$, $AlFe_3$, $MnZn_3$, $HgCd_3$, $SnCu_3$, $PdCu_3$, $TiAl_3$. EF (10)

The Microcharacter as a Metallurgical Instrument (and some properties of ferrite). JANET Z. BRIGGS. Thesis, Stanford University, May, 1933. 79 typed pages, 22 figures, 59 references. Unpublished, available at Stanford University Library. See "Properties of Ferrite as Revealed by Scratch Hardness Tests," *Metals & Alloys*, Vol. 5, July 1934, page 159. HWG (10)

Microscopic Examination of Iron-Tin Reaction Products. W. D. JONES & W. E. HOARE. *Iron & Coal Trades Review*, Vol. 128, June 29, 1934, pages 1047-1048, July 6, 1934, pages 9-10; *Sheet Metal Industries*, Vol. 8, Sept. 1934, pages 510-512; *Iron & Steel Industry*, Vol. 7, June 1934, pages 300-301. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 490. Ha + AWM + CEJ (10)

A Microcharacter Study of the Effects of Various Elements (C, Mn, Si) on the Hardening of Ferrite in Plain Carbon Steels. J. F. WILLIAMS. Thesis, Stanford University, April, 1934, 77 typed pages, 25 figures, 7 references. Unpublished, available at Stanford University Library. See "Properties of Ferrite as Revealed by Scratch Hardness Tests," *Metals & Alloys*, Vol. 5, July 1934, page 159. HWG (10)

The Electron Microscope and Its Significance in Metallurgy (Das Elektronenmikroskop und seine Bedeutung in der Metallurgie). F. BENNIGSON. *Die Metallbörse*, Vol. 24, May 12, 1934, pages 597-598. Busch discovered a few years ago that a bundle of cathode rays passing a magnetic field is diffracted in the same manner as light rays in an ordinary lens. The further evolution of the electron microscope is traced. Magnifications of 14,000 x are possible with electron rays. The samples under test must be placed in a high vacuum. The significance of electron rays in metallurgy arises from the fact that electron emission of constituents of an alloy varies and that enlargements of ordinary microscopes are limited. Microstructures of W, Ni and Pt-Rh revealed by electron rays are presented. The novel way opens a new field insofar as investigations of metals at elevated temperatures are possible. A chromatic electron lens has been invented recently by von Ardenne. EF (10)

Use of Cathode Ray Oscillograph for Studying Magnetization of Ferromagnetic Substances. (Sur l'Emploi de l'Oscillographe Cathodique pour l'Etude de l'Aimantation de Substances Ferromagnétiques). PIERRE BRICOUT & ROBERT SALOMON. *Comptes Rendus*, Vol. 199, Aug. 27, 1934, pages 529-531. Difference in magnetic properties of steels heated at 10° intervals in the region of 800° C. has been shown by use of a cathode ray oscillograph. Studies also made to correlate variation in magnetism with duration of heat treatment. FHC (10)

Notes on the Metallography of Light Metal Alloys. A. BLUMENTHAL. *Metallurgia*, Vol. 10, July 1934, pages 83-85. Translated from *Zeiss Nachrichten*, Apr. 1934, pages 28-34. Directions for polishing and etching are given. JLG (10)

Cadmium-Lithium Alloys (Ueber die Cadmium-Lithium-Legierungen). A. BARONI. *Zeitschrift für Elektrochemie*, Vol. 40, Aug. 1934, page 565. The results found in his previous investigations on compounds $LiCd_3$ and LiCd, their structure and crystallographic determination, are maintained in the face of contrary observations by Zintl & Schneider. See *Metals & Alloys*, Vol. 5, June 1934, page MA 280. Ha (10)

The High-zinc Region of the Copper-zinc Phase Equilibrium Diagram. E. A. ANDERSON, M. L. FULLER, R. L. WILCOX & J. L. RODDA. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 571, Sept. 1934, 29 pages. A determination of the high-Zn region of the Cu-Zn diagram is reported. The peritectic zone of the eta and epsilon phases was carefully determined and the results indicate that previously reported data are correct. The solid solubility of Cu in Zn was investigated in detail by X-ray, electric-conductivity, and microscopic methods applied to specimens prepared according to several different procedures. The solid solubility was 0.3% at 100° C. and 2.5% at 400° C. Between these 2 temperatures the solubility curve is a straight line on the diagram. The difficulty with which equilibrium in solid phases is reached is emphasized, and the necessity for determining solid solubility by several methods if real equilibrium values are to be found is stressed. 21 references. JLG (10)

Electrometric and X-ray Investigation on Solid Thallium-lead Alloys (Eine elektrometrische und röntgenometrische Untersuchung an festen Thallium-Blei-Legierungen). ARNE ÖLANDER. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 168, May 1934, pages 274-282. The electrode potentials of Tl-Pb alloys have been determined between 245° and 295° C. Previous investigations of Guertler & Schulze, Kurnakow & Puschin, Kurnakow & Schemschuschny, and Lewkonja on this diagram did not lead to correct values due to segregation effects in the alloys high in Tl. An intermediary phase of the chemical composition Tl_7Pb has been found to exist between 54.6 and 92.5% Tl. The cube edge length of 11 Tl-Pb alloys yielded:

at.% Tl	0	16.7	32.8	41.4	53.9	57.5	67.6	77.7	87.2	88.5	91.4	94.0
a =	4.9382	9251	9129	9068	8974	8919	8775	8622	8468	8450	8411	8407 A.U.

A phase boundary is assumed at 54.6% Tl. Difficulties in determining the narrow 2-phase range are pointed out and a further interpretation possibility set forth by Jette & Greiner with reference to the Fe-Si diagram (Transactions, American Institute of Mining and Metallurgical Engineers, Vol. 105, 1933, pages 259-275) is referred to. A characteristic tarnishing effect up to 54.6% Tl has also been noticed. EF (10)

Crystal structure of Thallium-Bismuth Alloys (Kristallstruktur der Thallium-Wismut-Legierungen). ARNE ÖLANDER. *Zeitschrift für Kristallographie*, Vol. 89, Aug. 1934, pages 89-92. The alloys of Bi and Tl show 2 intermediary phases. The Tl-rich one has a transformation point at 82°C. and belongs to the face-centered cubic system, like β Tl. The 2-phase range extends between 73 and 96% Tl. The second phase is hexagonal (like α-Tl), exists between 34 and 46% at.% Tl, contains 3 atoms per unit cell, belongs to the space group D^1_{6h} and has a specific gravity of 11.0. X-ray determinations cannot reveal the distribution of the Bi and Tl atoms. However determinations of the electric conductivity by Kurnakow, Schemschuschny & Turarin indicate that the atoms are not distributed at random. The conductivity was found to increase with Bi contents approaching the formula Bi_2Tl. A higher degree of symmetry in the cubic phase at the composition Tl_7Bi in analogy with Tl_7Pb (*See abstract above*) is suggested. EF (10)

Long Wave X-rays for Solving Special Structural Problems (Langwellige Röntgenstrahlen zur Klärung spezieller, kristallstrukturaller Fragen). H. O'DANIEL. *Zeitschrift für Kristallographie*, Vol. 88, July 1934, pages 304-316. The author constructed an X-ray equipment simultaneously with and independently from G. Hägg (See *Metals & Alloys*, Vol. 5, April 1934, page MA 153, R 7) whose "X-ray vacuum box" is considered to be impractical. The structural features of the new apparatus whose interchangeable members can be utilized in an ordinary X-ray equipment, are taken up at length. Extreme vacuum conditions were not found to be indispensable with long-wave radiation. Be foils for windows are too expensive, brittle and not vacuum-tight enough in the case of the thinner grades. Al foil of 6-7 μ is applied. Absorption = 0.57%. Cellophane windows are feasible presuming an additional distance of 50 mm. from the anti-cathode. Al radiation yielded the best results at 8 milliamps and 21.5 kvolts. The preparation of Si cathodes involves too many difficulties and has been abandoned. Due to inconveniences arising from Fe-contaminations in Al, a metal of 99.993% purity was utilized as anti-cathode material. Filtering of the long wave radiation is superfluous. EF (10)

Graphite in Low-carbon Steel. A. B. KINZEL & R. W MOORE. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 565, Sept. 1934, 6 pages. A low-C steel taken from a cracking still that had been in operation for 3 years and at a temperature just below the eutectoid was found to consist of ferrite and graphite. The steel analyzed 0.15 % C, 0.49 % Mn, 0.015 % P, 0.023 % S, and 0.02 % Si. Samples from the tube were heated to 850° C. for different times and their structure examined. At this temperature graphite was slowly absorbed and pearlite was formed on subsequent cooling. The occurrence of graphite in the tube offers rather conclusive proof that the stable system below the eutectoid contains graphite and not cementite. JLG (10)

X-Ray Studies on the Diffusion of Metals in Copper. CHUJIRO MATANO. *Japanese Journal of Physics*, Vol. 9, June 15, 1934, pages 41-47. The coefficient of diffusion of Al, Mn, Ni, Zn, Pd, Sn, Pt, and Au in Cu was determined by the X-ray method between the temperatures of 400° and 950°C. While at the higher temperature the coefficient does not depend upon the previous treatment of the alloys, at the lower temperature it depends very much on that. From the recent investigations on the diffusion of the Cu-Ni system which were carried out, at 1025°C., chemically by G. Grube and A. Jedele and at 500°C. by the method of X-ray analysis by the author, it became evident that even in solid solutions, the coefficient of diffusion given by Fick's law is not a constant but must be considered as a fuction of the concentration of the component metals. Method and results of the experiment are discussed. Kz (10)

Transformation Phenomena in β-Aluminum Bronzes (Umwandlungsvorgänge in β-Aluminiumbronzen). G. WASSERMANN. *Die Giesserei*, Vol. 21, July 20, 1934, page 311. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 492. Ha (10)

Investigations on Temper Hardness. II. Unusual Phenomena in High Silver-Aluminum Alloys during Heat Treatment (Untersuchungen ueber die Anlasshaertung der Legierungen. II. Abnorme Erscheinungen bei der Silberreichen Aluminum in Silberlegierung waehrend der Waermebehandlung). DENZO UNO & SADAMU YOSIDA. *Journal Society of Chemical Industry, Japan*, Vol. 36, Apr. 1933, page 172B. Tests were made by differential dilatometry, direct and differential thermal analyses, and hardness measurements at high and low temperatures. MAB (10)

Magnetic Transformation in Carbon Steels during Quenching. I. N. ZAVARINE. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 548, Feb. 1934, 13 pages. An apparatus suitable for determining temperatures of magnetic transformation during slow cooling or heating and during quenching is described. Electrolytic Fe, ingot Fe, and commercial steels containing as much as 1.19% C were studied. Results with relatively slow heating and cooling showed that magnetic transformations were not related to phase changes in steels containing less than 0.60% C. In the quenching experiments all steels were quenched at a rate that produced martensite. In quenching the magnetic transformation was spread over a wide range of temperature, 800 to 250° C. for electrolytic Fe, 630 to 100° C. for a 45% C steel, and 250 to 100° C. for a 1.19% C steel. In discussion it is concluded that the magnetic transformation observed is independent of phase changes. 10 references. JLG (10)

The Constitution of Iron-rich Fe-Al-C Alloys. F. R. MORRAL. *Iron & Steel Institute, Advance Copy* No. 8, Sept. 1934, 10 pages. Alloys were prepared by first melting Fe and C in an Al_2O_3 crucible and then adding Al. The alloys produced contained as much as 28% Al. They were heat treated and then studied by microscopic and X-ray methods. The following phases were identified: (a) α-Fe solid solution with random distribution or with superstructure corresponding to Fe_3Al or FeAl, (b) austenite containing some Al and C, and (c) a hard and brittle phase ε, in which the metal atoms are arranged in a cubic lattice with 4 atoms in the unit cell. In this last phase the Al atoms occupy the corners of the elementary cube and the Fe atoms the center of the faces. The length of the unit cube varies from 3.73 to 3.77 A. U. The metal composition corresponds to Fe_3Al but it contains also about 4% C. A section of the tentative diagram for 1000° C. is shown. JLG (10)

Some Aspects of the Pearlitic Structure of a Steel of 0.22% C in the Wire-Testing Machine of 5 mm. Diameter (Quelques Aspects de la Structure perlitique d'un Acier à 0.22% de Carbone à l'état de Fil-Machine de 5 mm. de Diamètre). J. SEIGLE. *Revue Technique Luxembourgeoise*, Vol. 26, July-Aug. 1934, pages 82-95. When preparing specimens of wire for the testing machine it was observed that the manner of cooling after annealing had some influence on the structure of the wire; the steel used had 0.22% C, 0.63% Mn, 0.32% Si, 0.018% P, 0.035% S. The exhaustive mechanical and metallographical examinations (illustrated in micrographs) show that cooling in the furnace produces the usual cellular structure the appearance of which changes in every region examined with C content. Cooling in air changes the appearance of regions with 0.4% and more C very little and produces a much more cut-up structure in regions of about 0.20-0.30% C and somewhat less cut-up in regions with 0.10-0.15% C. Ha (10)

Equilibrium Mechanism of Minute Crystals III (Ueber den Mechanismus des Gleichgewichtes kleiner Kriställchen. III.) I. N. STRANSKI & R. KAISCHEW. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 26, Aug. 1934, pages 312-316. It is shown that the Gibbs-Wulff rule, according to which the central distances during the equilibrium state are proportional to the corresponding specific surface energies, coincides with the rule that the Φ values must be identical for all planes of the equilibrium form (Φ = separation or splitting-off energy, "Abtrennungsarbeit"). A summary of those equilibrium forms which have been experimentally determined on face-centered-cubic crystals (Ag) and hexagonal-close-packed crystals (Mg, Cd, Zn, Be) is given and the experimental results compared with the theory. EF (10)

K-Series X-Ray Emission-Lines of Iron in Several Compounds. SHINSUKE TANAKA & GENJIRO OKUNO. *Japanese Journal of Physics*, Vol. 9, June 15, 1934, pages 75-79. The $K\alpha_1$, $\alpha_2\beta_1$, and β' lines of Fe were investigated by means of the secondary method for the pure element and several compounds. $K\beta'$ was separated from $K\beta_1$ in the case of Fe_2O_3 and FeS. Displacement of the $K\beta_1$ lines of the compounds relative to that of the pure element, especially in the case of FeS_2, and peculiarity in the Kα-doublet were detected. Kz (10)

On the Magnetic Investigation of the Amount of Retained Austenite in Quenched Steels. MIWAKITI MIKAMI. *Kinzoku no Kenkyu*, Vol. 11, May 1934, pages 225-250 (In Japanese); *Science Reports Tohoku University*, Vol. 23, 1934, pages 213-241 (In English); *Journal Society of Mechanical Engineers*, Vol. 37, Apr. 1934, pages 217-224. The amount of retained austenite in quenched steels was determined by the magnetic method. The samples were made of five Swedish steels containing respectively 0.37, 0.57, 0.85, 1.08 and 1.27 per cent of carbon. After the specimens had been quenched in vacuum, the magnetization curve, I-H, was taken by the ballistic method, from which the relation between the saturation value of magnetization and the quenching temperature was obtained. This relation shows approximately the amount of retained austenite. Besides, the change of magnetization of quenched specimens during heating from room temperature to 600° was determined by a magnetometer, and it was found that in tempering a quenched steel, the increase of magnetization below 150° is due to the transformation α- $\longrightarrow$ β-martensite, and that of higher temperatures is due to the decomposition of retained austenite. In the case of a hypo-eutectoid steel quenched from below the A_3 line, the amount of retained austenite is greater than that of the same steel quenched from gamma field. In the case of an 0.85 per cent carbon steel, the amount of retained austenite increases with the rise of quenching temperature, reaches a maximum at 900° and then decreases. In the case of a hyper-eutectoid steel, the amount of retained austenite always increases with the quenching temperature. In the case of quenching from a temperature below the A_{cm} line, the amount of retained austenite decreases with the increase of carbon content. The amount of retained austenite in quenched steel is principally affected by the concentration of carbon in gamma iron, but not by the total carbon in the specimen. KT + Kz (10)

Metallographic study of the transformations of Ni-Cr steel (Etude Metallographique des transformations de l'acier au chrome-nickel). V. KOSELEV & F. POBORIL. *Collection of Czechoslovak Chemical Communications*, Vol. 6, Mar. 1934, pages 107-115. This is a preliminary report of the general study of special steels made at Skoda Works. A Ni-Cr steel of the analysis: 0.45% C, 0.57% Mn, 0.36% Si, 0.009% P, 0.006% S, 0.88% Cr, and 3.14% Ni has been studied under three different rates of cooling. 1. A rate of cooling of 0° C. to 340° C./hr. produces in the range of 780° C. to 550° C. a structure of pearlite and troostite. 2. A rate of cooling of 100° C. to 2400° C./hr. produces primary martensite in the region 500° C. to 200° C. and 3. cooling at more than 100° C./hr. and in the interval 350° C. to room temperature the secondary martensite II is produced. Martensite I is very unstable. GTM (10)

The Crystal Structure of Iron. C. A. EDWARDS. *Mechanical World & Engineering Record*, Vol. 96, Aug. 10, 1934, pages 122-123; Aug. 17, 1934, pages 147-148. Abstract of the William Menelaus Memorial Lecture presented to the South Wales Institute of Engineers. Kz (10)

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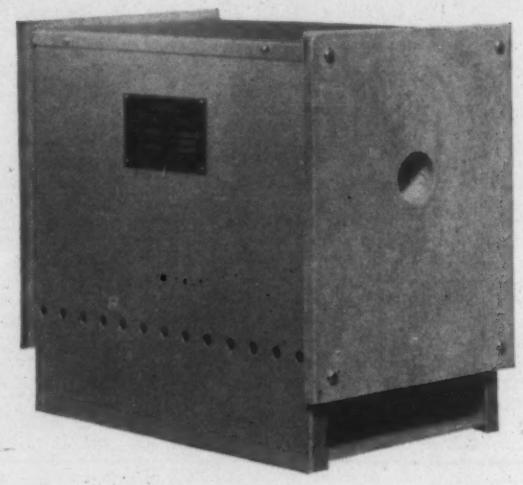

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The Decomposition of Martensite. GUNNAR HÄGG. *Iron & Steel Institute, Advance Copy* No. 5, Sept. 1934, 13 pages. Previous X-ray studies of martensite are described. From these and from data obtained on quenched steels and steels quenched and then reheated to 150 °C. for 30 min. it was concluded that cubic martensite (Honda's β) does not exist. The structural element described as cubic martensite probably consists of tetragonal martensite in which the tetragonal symmetry is not observable owing to the low C content. The speed of reduction of C content of martensite during low-temperature tempering was determined by X-ray methods. The loss of C during a given time is the greater the greater is the C content, but the curve of C loss against time cannot be expressed by a simple equation. 13 references. JLG (10)

Crystallization Diagrams of the System Copper-lead-sulphur (Kristallisationsdiagramme des Systems Kupfer-Blei-Schwefel). W. GUERTLER & G. LANDAU. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 218, July 14, 1934, pages 321-345. In the general diagram Cu-Pb-S which has been fully established previously (see same authors, *Metall & Erz,* 1934, page 169), the partial triangle of the spatial diagrams Pb-Cu_2S-Cu and Pb-Cu_2S-PbS were developed and the equilibria of all alloys possible discussed. 2 groups of alloys are distinguished, one in which the alloy, at the beginning crystallization, consist of a single layer only, the other, where they consist of 2 layers of which the upper contains cuprous sulphide, little Cu, little Pb, and the lower layer little cuprous sulphide, Cu, Pb. Disintegration of the lower layer into a Cu-rich and a Pb-rich layer was not observed. Thermal analyses of several alloys are described in full. Ha (10)

Electric Conductivity and Binary Diagrams (Elektrische Leitfähigkeit und Zustandsdiagramm bei binären Legierungen). XIII. Formation of Solid Solutions in the System Magnesium-Tin (Ueber Mischkristallbildung im System Magnesium-Zinn). G. GRUBE & H. VOSSKUEHLER. *Zeitschrift für Elektrochemie,* Vol. 40, Aug. 1934, pages 566-570. Electric conductivity and thermal expansion, the solidus line and the limits of Mg-rich solid solutions were exactly determined; conductivity and expansion show similar character, both decreasing steeply in the range of solid solutions and having a minimum at Mg_2Sn, corresponding to 33.3% Sn; this is the only compound in the system.—**XIV. The System Lithium-Thallium (Das System Lithium-Thallium).** G. GRUBE & G. SCHAUFLER. *Ibidem;* pages 593-600. The complete Li-Tl diagram was developed from thermal analyses and temperature-resistance curves of solid alloys. The existence of intermetallic compounds LiTl, Li_2Tl, Li_5Tl_2, Li_3Tl and Li_4Tl could be determined; all but the first are pink to violet. LiTl, Li_5Tl_2 and Li_3Tl can be melted without disintegration, at practically the same temperature for all, 448°C. Li_2Tl and Li_4Tl disintegrate upon melting at 381°C. Ha (10)

Studies of Phase Changes during Aging of Zinc-alloy Die Castings, I.—Eutectoidal Decomposition of Beta Aluminum-zinc Phase and Its Relation to Dimensional Changes in Die Castings. M. L. FULLER & R. L. WILCOX. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 572, Sept. 1934, 17 pages. Decomposition of the β phase of the Al-Zn system was studied with the object of determining its effect on shrinkings of Zn-alloy die castings during aging. The β phase decomposes in less than one week of aging in die castings. This rapid decomposition takes place in spite of Cu and/or Mg present in Zn die castings. Alloys containing Mg, however, require over 6 weeks for complete decomposition at room temperature. The increase in density or shrinkage that accompanies the β decomposition was measured and found to be consistent with the shrinkage calculated from crystal-structure data. Decomposition of the β phase cannot be the sole cause of aging shrinkage in die castings. Other data obtained on the β phase include the heat of decomposition, and eutectoid temperature, and some applicable for explaining the mechanism of decomposition. 17 references. JLG (10)

Electrode Potentials of the Structural Elements of Aluminum Alloys (Die Elektrodenpotentiale der Strukturbestandteile von Aluminiumlegierungen). G. W. AKIMOW & A. S. OLESCHKO. *Korrosion und Metallschutz,* Vol. 10, June 1934, pages 133-135. The electrode potential is of importance in corrosion. As intermetallic compounds determine this behavior, the potentials were determined on monocrystals of $CuAl_2$, $FeAl_3$, $MnAl_3$, Mg_2Si_2 and $NiAl_3$ against a 3% NaCl solution; intermetallic compounds have higher potentials than solid solutions of the same system. The results are given in 2 tables. Ha (10)

Affinity of Phosphorus for Iron (Ueber die Verwandtschaft von Phosphor zu Eisen). W. FRANKE, K. MEISEL & R. JUZA. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 218, July 14, 1934, pages 346-359. Of the fairly great number of assumed iron-phosphides, only the 2 lower phosphides Fe_3P and Fe_2P and the 2 higher FeP and FeP_2 could be established, the latter 2 without certainty. Their properties and characteristics, density, X-ray diagram, and thermal behavior, were investigated. Ha (10)

Neumann Bands in 18-8. FRANCIS B. FOLEY. *Metal Progress,* Vol. 26, Sept. 1934, page 42. Shows Neumann bands produced in 18-8 by shock of explosion. WLC (10)

Equilibrium Relations in Aluminum-nickel Alloys of High Purity. WILLIAM L. FINK & L. A. WILLEY. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 569, Sept. 1934, 11 pages. The portion of the equilibrium diagram for high-purity Al-rich alloys containing up to 18% Ni was determined. In this region the phases are the Al-rich solid solution and $NiAl_3$. There is a eutectic at 639.9 °C. and 5.7% Ni. The liquidus at 18% Ni is at about 820 °C. At the eutectic temperature the solid solubility of Ni in Al is 0.05%; at 500 °C. it is 0.005%. Alloys can be age hardened, as is suggested by the curve of solid solubility. 7 references. JLG (10)

Fe-Pt Alloys. Curie Point and Magnetic Moments (Les Alliages Fer-Platine. Point de Curie et Moments Magnétiques). MAURICE FALLOT. *Comptes Rendus,* Vol. 199, July 9, 1934, pages 128-129. Up to 3.7 atomic % Pt, alloys of Fe-Pt have same Curie point as Fe. As % Pt increases, alpha to gamma transformation occurs at higher temperature than gamma to alpha. The mean atomic moment increases as Pt content increases and reaches a maximum at 12.5% Pt. FHC (10)

The Weissenberg Reciprocal Lattice Projection and the Technique of Interpreting Weissenberg Photographs. M. J. BUERGER. *Zeitschrift für Kristallographie,* Vol. 88, Aug. 1934, pages 356-380. In English. The form of the reciprocal lattice line curves on Weissenberg photographs is derived for (1) X-ray beam inclined $\beta = \mu$ to the rotation axis, (2) X-ray beam normal to the rotation axis. For the former case a curve form template is constructed and its use in indexing a film is discussed and the most convenient design of Weissenberg apparatus for making use of an inclined beam is described. EF (10)

Classification of Alpha Iron-nitrogen and Alpha Iron-carbon as Age-hardening Alloys. JOHN L. BURNS. *Metals Technology,* Aug. 1934, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 556, 20 pages. Age-hardening effects of C, N, and O are considered and it is suggested that C is effective in precipitation hardening of ordinary steels quenched from below A_1, N is effective in weld deposits, and that O plays no significant part in hardening. Accurate X-ray measurements indicated that both N and C in solution in α Fe increase lattice parameter. On age hardening, lattice parameter remains unchanged. The change in properties on age hardening Fe containing N and C were determined. From the behavior it was concluded that Merica's knot theory serves to explain hardening by N and C in α Fe. 18 references. JLG (10)

Studies on the Transformation of Metals by Secondary Electron Emission. KAZUMA HAYAKAWA. *Kinzoku no Kenkyu,* (In Japanese) Vol. 11, May 1934, pages 219-224; *Science Reports, Tohoku University,* Vol. 22, 1933, pages 934-957. In English. New methods of studying the transformation of metals were investigated and proved to be successful: (a) a method of measuring the secondary electron emission excited by the thermionic current at various temperatures: (b) a method of measuring the ionization current at various temperatures. At the A_3 transformation of iron, secondary electron emission is independent of the velocity of the primary electrons. During the A_2 transformation of iron, the variation of the secondary electron emission with respect to the course of the same current above the critical point is continuous; it changes sign above and below a certain value of the primary excitation voltage, called the "critical voltage." In nickel, cobalt, and iron-nickel alloys, secondary electron emission shows a similar change in the range of the magnetic transformation. By measuring the intensity of ionization current in an evacuated tube, which contains a minute quantity of hydrogen gas, at various temperatures it was observed that the ionization current makes also a characteristic change at the A_3 transformation point and also in the range of magnetic change. KT (10)

Gradual Transition and Critical Point Between Two Solid Phases (Stetiger Übergang und kritischer Punkt zwischen zwei festen Phasen). U. DEHLINGER. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 26, Aug. 1934, pages 343-352. X-ray investigations of transformation kinetics of solid metallic phases revealed in practically all cases a gradual transition between different crystal lattices. The problem whether these gradual transitions are possible in thermodynamic equilibria is theoretically discussed with reference to the cubic ⟶ tetragonal transformation of the superstructure in AuCu. Based on previously investigated electron arrangements in this alloy, it is derived that the connection between the regularity of the atom distribution and the tetragonal axial ratio must depend on the pressure. The evaluation of the thermodynamic equilibrium (whereby the introduction of an entropy factor depending on the lattice symmetry becomes rather important) showed that an unsteady transition takes place at low pressures and a gradual transition prevails at high pressures and that a critical point must be expected in between. This steady transition is a so-called phase change of secondary order. EF (10)

Mechanism of the Grain Refinement of Alloys by Peritectic Reaction. JUN ASATO. *Kinzoku no Kenkyu,* Vol. 11, July 1934, pages 317-327. In Japanese. By the microscopic observation of peritectic alloys and also from the theoretical consideration of the peritectic reaction, it has been concluded that the peritectic reaction takes place suddenly—like supercooled molten metal—and that during the peritectic reaction the dendritic primary crystal is disintegrated into many fragments by the liquid which lies in the interstices and as these fragments behave as separate nuclei for each peritectic crystal, the grain size of the latter becomes very fine. KT (10)

Ternary System Magnesium-zinc-calcium (Sur les alliages ternaires magnesium-zinc-calcium). RENE PARIS. *Comptes Rendus,* Vol. 197, Dec. 18, 1933, pages 1634-1636. See *Metals & Alloys,* Vol. 5, July 1934, page MA 351. OWE (10)

The Influence of Diffusing Elements upon the Alpha-gamma Inversion of Iron. W. D. JONES. *Iron & Steel Institute, Advance Copy* No. 7, Sept. 1934, 9 pages. Alloys that diffuse into Fe may be classified according to whether they inhibit or extend the γ modification. Behavior of the 2 classes during diffusion above and below the A_3 point are described. By observation of diffusion boundaries formed with pairs of alloys of known compositions the limits of the γ loop can be established. By this method the loop at 1150 °C. was fixed at 3.75% As, 4.25% Sb, and 17.5% Zn. It is suggested that there is a relationship between the heat of oxidation of a metal and its influence on the α-γ inversion in Fe. 12 references. JLG (10)

An X-Ray Study of the Binary Alloys of Silicon with Silver, Gold, Lead, Tin, Zinc, Cadmium, Antimony and Bismuth. ERIC R. JETTE & EMERY B. GEBERT. *Journal of Chemical Physics,* Vol. 1, Nov. 1933, pages 753-755. Si of exceptional purity (99.79% Si, .027% Fe, .008% Al, .014% Ca, .004% C, .002% O_2, .1% N_2 and trace of H_2) was melted in 2 different ways with Ag, Au, Pb, Sn, Zn, Cd, Sb, and Bi and the lattice constants of the binary alloys were measured. It is shown that the lattice constants of the elements in these alloys are practically identical with those of the pure elements. This fact leads to the interpretation that mutual solubility of the elements in these alloys occurs to only a very slight extent, namely .2% Ag in Si, .5% Sb in Si. It is further observed that Si forms no compounds with any of these elements. Attention is called to the fact that Si has been observed to form compounds with all of the first 20 elements of the periodic system except its immediate neighbors Al and P, the rare gases and the 2 alkali metals Na and K. Of the metallic elements remaining in the periodic system, compound formation or extensive solid solution may be expected only in the alloys with transition elements with the atomic numbers 21-28, 39-46, 57-78. The only thoroughly established exception to this statement is Cu and it has been observed that this element in alloys sometimes exhibits the behavior of a transition element. WH (10)

Intermetallic Solid Solutions. ERIC R. JETTE. *Metals Technology,* Aug. 1934, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 560, 16 pages. It is assumed that chemical and physical requirements that must be fulfilled by solvent and solute atoms or molecules to enable solutions to obey Raoult's law are identical with those required for the additivity law of Vegard to hold for solid solutions. A study of the results of a number of accurate determinations of lattice constants in intermetallic systems where extensive ranges of solid solution occur shows that while a number of solutions obey the additivity law, positive and negative deviations are of frequent occurrence and considerable magnitude. The effects of change of coordination number and superstructure formation on lattice constants are considered, and the mutual effect of unlike atoms in the solid state upon the effective atomic radius is briefly discussed. 42 references. JLG (10)

Use of Reflected Polarized Light in the Study of Inclusions in Metals. S. L. HOYT & M. A. SCHEIL. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 567, Sept. 1934, 19 pages. The polarizing microscope can be used for the identification of optically active, glassy, and crystalline inclusions in steel. Inclusions of the globular type of silicates show an optical cross whether large or small when observed with crossed nicols. The identification of certain types of inclusions is discussed in some detail and many micrographs contrasting ordinary observations with those using polarized light are shown. Al_2O_3 particles can be readily identified, and it is easy to determine whether or not Al_2O_3 and silicates contain FeO. JLG (10)

Nature of a Solid Solution. K. HONDA. *Metal Progress,* Vol. 26, Sept. 1934, pages 42-43. Density of 4.5% Al-Ag alloy discussed. Experimental results check within 0.3% density calculated from known displacement of Ag lattice by Al in solid solution. WLC (10)

Powder Photograms of a New Iron Carbide (Pulverphotogramme eines neuen Eisen karbids). GUNNAR HÄGG. *Zeitschrift für Kristallographie,* Vol. 89, Aug. 1934, pages 92-94. In the introduction the latest findings of Fischer & Bahr, Gluud, von Otto & Richter, Hofmann & Groll, Bahr & Jessen on the probable existence of unknown Fe-carbides (Fe_3C_4, Fe_2C) are summarized. The author X-rayed a preparation secured by treating Fe with CO for 430 hrs. at 225°C. The new lines obtained probably belong to an Fe-carbide of the formula Fe_3C. At higher temperatures the amount of Fe_3C increases at the expense of the new carbide. On heating in vacuum at 500°C. the new lines vanish and only Fe_3C reflections remain. It is not impossible that this new carbide phase plays a role during the decomposition of martensite and austenite and that it occurs during the formation of cementite from Fe and C. Hägg did not detect the lines of the new carbide during annealing of quenched C steels. EF (10)

The Habits and Laws of Decomposition of Supercooled Solutions, with Special Regard to Austenite. G. B. Upton. *Transactions American Society for Metals*, Vol. 22, Aug. 1934, pages 690-727. A new Fe-Si equilibrium diagram is presented keeping α and β phases distinct, which better explains the properties and structures of these steels. The temperature lag before pearlite is formed varies with the cube root of the cooling rate. Methods of controlling the lag in supercooling of austenite are described. With discussion. WLC (10)

Graphical Determination of the Various Parts of Cementite and Ferrite in the Non-Carbon Diagram (Die graphische Bestimmung der verschiedenen Zementit-und Ferritanteile im Eisen-Kohlenstoff-Diagramm). H. Uhlitzsch. *Die Giesserei*, Vol. 21, July 6, 1934, pages 281-282. The method of Sauveur for the graphical evaluation of the Fe-C diagram is explained and modified in such manner that the accuracy is increased and the shares of the different Fe carbides in the structure for any C content can be read directly. Ha (10)

Spherical Al-Fe-Si Eutectic Precipitated in Pure Aluminum (Über kugelförmig ausgeschiedenes Al-Fe-Si-Eutektikum in Reinaluminium). H. Röhrig & E. Käpernick. *Metallwirtschaft*, Vol. 13, Aug. 24, 1934, pages 591-593. While examining pure Al, containing 0.10% Fe and 0.10% Si, a new microscopic constituent was found, spherical in shape, with a maximum dia. of .03 mm. It occurs inside the grains, irregularly distributed, and is not elongated in thin sheets. By remelting and very slow cooling it disappears. When an Al alloy containing 1.92% Si and 1.06% Fe is cooled rapidly or slowly from the molten condition, needle shaped $Al_6Fe_2Si_3$ and Si are formed at the grain boundaries. But if this alloy is annealed at 600° or 620° C. and then quenched, the small spherical eutectic constituent is formed inside the grains, similar to that obtained in pure Al without annealing. The eutectic is formed while the alloys pass from the liquidus to solidus, providing the cooling rate is fast enough. CEM (10)

Reciprocal Miscibility of Alloys of Copper and of Lead (Miscibilité réciproque des Alliages de Cuivre et de Plomb). A. Ricard & H. Ackermann. *Cuivre et Laiton*, Vol. 7, June 30, 1934, pages 275-278. Failures which were experienced in earlier periods of the use of Cu-Pb alloys must be attributed to insufficient knowledge of their properties. Present methods permit producing homogeneous alloys which are excellent antifriction metals. Melting and heat-treatment practice is discussed and illustrated by photomicrographs. Ha (10)

Smoothing and Etching, Rapid Metallographic Methods. H. B. Pulsifer. *Metal Progress*, Vol. 26, Aug. 1934, pages 31-34. Describes and illustrates with micrographs technique of rapid hand preparation of microspecimens on moist pat or pile of abrasive. Light etching of the surface during this smoothing operation is effective in more rapid preparation of a suitable surface. WLC (10)

Ideal Magnetization of a Crystal of Iron (L'Aimantation Idéale d'un Cristal de Fer.) Stephan Procopu. *Comptes Rendus*, Vol. 199, July 9, 1934, pages 126-127. Ideal magnetization is defined as that acquired by a ferromagnetic substance subjected to a constant magnetizing force with the addition of an AC magnetic field having an amplitude falling off to zero. Under these conditions the coercive force of a single Fe crystal tends towards zero. Derivation shown from expressions of ideal permeability and laws of alternating currents. FHC (10)

Similarity Between Abnormality and Aging. A. Portevin. *Metal Progress*, Vol. 26, Sept. 1934, pages 38-39. Similarity of influences causing abnormality of structure and aging effects are cited. Studies of these influences make possible, by adequate treatment and alloy addition, production at will of required grain size, normality and stability. WLC (10)

Effect of Quenching Strains on Lattice Parameter and Hardness Values of High-purity Aluminum-copper Alloys. Arthur Phillips & R. M. Brick. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 563, Sept. 1934, 19 pages. Although Cu decreases lattice parameter of Al, some Al-rich alloys containing Cu have a parameter larger than that of pure Al. Alloys containing 2.4, 5.46, and 15% Cu were prepared, given different heat treatments, and their lattice parameters determined by the back-reflection method. After a rapid quench from precipitation-treatment temperatures the parameter was greater than that of pure Al. The increased parameter cannot be attributed to strains introduced by the precipitation of $CuAl_2$. It can be explained by quenching strains, for the larger specimens in which larger quenching strains were introduced had the larger lattice parameters. The specimens with a large lattice parameter hardened on aging while those with normal parameters did not. Parameter values were larger with increasing specimen size, with increase in rapidity of cooling, and with increased Cu content of Cu in solid solution. Experiments with Al foil over the Al-Cu alloys proved that only the outer 0.004" of the specimen influenced the X-ray patterns when Cu radiation was used. 8 references. JLG (10)

Growth of Metal Crystals in Metal Vapor. III. (Das Wachstum von Metallkristallen im Metalldampf. III). M. Straumanis. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 26, July 1934, pages 246-254. The third instalment (See *Metals & Alloys*, Vol. 3, May 1932, page MA 126; Vol. 5, Feb. 1934, page MA 45 LA7) reports on sublimation tests with Mg below its melting point and at pressures ranging from 0.001-360 mm. Hg. The experiments were carried out in an atmosphere of H_2. Previous sublimation tests on Cd are supplemented and the phenomena of crystal growth observed with the 3 close-packed hexagonal metals (Mg, Zn, Cd) are summarized. The theory of homopolar crystal growth advanced by Kossel and Stranski could be verified on Mg whose crystals were distinguished by the (0001), (10$\bar{1}$0) and (10$\bar{1}$1) planes. Mg crystals can be deformed quite easily. The slip phenomena correspond to those noticed on Zn. The orientation of the crystals with respect to the Fe carrier is chaotic. Under certain testing conditions Fe crystals can be secured showing the (0001), (10$\bar{1}$0) and (10$\bar{1}$1) planes. EF (10)

The Cu_2Mg phase in the Copper-Magnesium System. V. G. Sederman. *London, Edinburgh, & Dublin Philosophical Magazine & Journal of Science*, Vol. 18, Aug. 1934, pages 343-352. Renewed investigation into the question of a homogeneity range in the neighborhood of and in the Cu_2Mg phase proved its actual existence. The parameters of the α and β phases in the $(\alpha + \beta)$ region and of the β phase in the $(\beta + \gamma)$ region were determined in the temperature range 380° to 600° C. The saturation composition of the α phase varies greatly with temperature. Ha (10)

Measurement of the So-called Crystallization Force. Preliminary Report. (Vorläufige Mitteilung über die Messung der sogenannten Kristallisationskraft). A. Schubnikow. *Zeitschrift für Kristallographie*, Vol. 88, Aug. 1934, pages 466-469. A dynamometer has been constructed with the object of determining the crystallization force of growing crystals. The same principle was previously used by Correns (*Sitzungsberichte der Preussischen Akademie der Wissenschaften, Physikalisch-Mathematische Klasse*, 1926, Vol. 11, page 1) who measured the force with which a growing crystal pushes along an object placed in its path. EF (10)

The Deformation Lines in Alpha Brass. Carl H. Samans. *Journal Institute of Metals*, Vol. 55, 1934 (Advance Copy), 5 pages. A microscopic study of 70:30 brass single crystals of 2 different orientations which had been reduced 50% in thickness by cold rolling revealed the presence of many lines of deformation. X-ray examinations, by the Davey-Wilson method, of the orientations in the rolling plane showed that the markings were mechanical twins parallel to octahedral planes. JLG (10)

Various Forms of Graphite and Cementite in Cast Iron. Roland Mitschke. *Metal Progress*, Vol. 26, Sept. 1934, page 45. Defines and classifies various forms of graphite and cementite according to time and manner of formation. WLC (10)

PROPERTIES OF METALS & ALLOYS (11)

1 **The Economic Selection of Metal Parts in Product Design.** L. H. Morin. *Product Engineering*, Vol. 5, Oct. 1934, pages 372-374. Illustrations by several examples of small parts that not only proper selection of a material for a given purpose, but also full utilization of its useful properties is needed for an efficient and economic product. Ha (11)

Vibrations Produced in Bodies by Contact with Solid Carbon Dioxide. Mary D. Waller. *Proceedings Physical Society*, Vol. 45, Jan. 1933, pages 101-116.

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The Production of Sounds from Heated Metals by Contact with Ice and Other Substances, Vol. 46, Jan. 1934, pages 116-123. Loud notes can be produced by bringing metal bars having natural vibrational frequencies varying from 1000 to 15000 c.p.s. in contact with solid CO_2. This phenomenon apparently depends on the sublimation of the CO_2 and the production of considerable gas pressures when it is brought into light contact with the metal. Soft notes can also be produced by bringing metal bars heated to suitable temperatures into contact with such substances as ice, camphor, iodine, oxalic acid, and ammonium phosphate. JCC (11)

2 **Compression Tests with Structures of Composite Sections of Small Cross-section (Knikproeven van constructies van samengestelde doorsnede met geringe slankheid).** M. G. Driessen. *De Ingenieur*, Vol. 49, May 4, 1934, pages A160-A162. Diagrams taken under compression tests of slender rods indicate that after exceeding the compression limit a sudden collapse follows in all members of the composite section. In general, it is stated that the ultimate strength under tensile stress corresponds to flow limit under compression stress. Ha (11)

3 **Wear of Metallic Materials through Rubbing Oxidation (Die Abnutzung von metallischen Werkstoffen durch die Reiboxydation).** Max Fink. *Die Chemische Fabrik*, Vol. 7, March 21, 1934, page 96. When steel, pure Fe, Cu or Ni are tested on an Amsler wear testing machine in an atmosphere of O or in air considerable wear takes place, but when they are tested in N there is hardly any wear. The dust resulting from wear contains Fe_3O_4 and Fe_2O_3, Cu_2O and CuO, NiO and higher oxides. Soft Fe and Cu wear also in N, but much less than in air. The pressure cold works the crystals on the surface of the metal and causes them to be temporarily very active chemically. It is possible that a thin oxide layer forms which is removed by wear, then another oxide layer forms, etc. In N no oxide layers form and wear proceeds more slowly. Covering with oil does not eliminate wear completely, due to dissolved O in the oil. Colloidal graphite in the oil improves wear resistance, the graphite forming a protective coating on the metal. Fatigue breaks may be caused by wear oxidation, as it proceeds along grain boundaries. CEM (11)

4 **Studies on Red Cast Brass for the Establishment of a Basic Classification of Non-Ferrous Ingot Metals for Specification Purposes.** C. M. Saeger, Jr. *Transactions, American Foundrymen's Association*, Vol. 5, June 1934, pages 67-96. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 456. CEJ (11)

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Electrical Resistance Materials (Über elektrische Widerstandswerkstoffe). A. Schulze. *Zeitschrift für Metallkunde*, Vol. 26, June 1934, page 140. Roundtable discussion. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 456. FNR (11)

5 **The Measurement of the Viscosity of a Molten Metal by means of an Oscillating Disc.** Vaughan H. Stott. *Proceedings Physical Society*. Vol. 45, July 1933, pages 530-544. Includes discussion. The theory of the logarithmic decrement method of determining the viscosity of molten metals by the use of an oscillating disc is investigated, and the corrections necessary at high temperatures discussed. The apparatus must be calibrated on molten metals having closely similar viscosities and densities to those under investigation. Using an alumina disc, the viscosity of molten tin was determined over the temperature range 238-800° C. No discontinuity was found in the viscosity-temperature curve over this range. JCC (11)

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A Photographic Method of Deriving the Optical Constants of the Metals. S. E. Williams. *Proceedings Physical Society*, Vol. 45, Jan. 1933, pages 49-66.

6 A method is described of determining the optical constants of metals. Gratings are ruled from thin films which have been deposited on glass in vacuo, and measurements are made by a photometric method of the intensity ratio of the central reflected and the first principal diffracted images, using light plane polarised both in and perpendicular to the plane of incidence. With spluttered platinum films, using the yellow doublet of the mercury arc, the values found were $k = 1.40$ and $n = 1.67$. JCC (11)

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Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

7 **Special Alloys (Speziallegierungen).** *Zeitschrift für die gesamte Giesserei-praxis*, Vol. 55, June 24, 1934, page 268; July 8, 1934, page 290; July 22, 1934, page 310. In these instalments on special alloys are discussed composition, properties and application of (1) Harder-McFarland alloys (corrosion-resistant Ni- Cr- Cu alloys) (2) Harpers metal, containing 43.8% Bi, 25% Sn, 25% Pb, 6.2% Cd, (3) Hardit, heat resisting Ni-Cr alloys of varying composition, (4) Haynes metal, corrosion and heat resisting Co- Cr- W alloys, (5) Hauvels bronze a Pb bronze with 86% Cu, 14% Sn + Pb, (6) Helmet bronze, (7) Hélouis Pt bronze varying in composition according to application, as for metal parts of telescopes, for scientific instruments and other utensils, (8) Heyne-Biddery alloy, an alloy containing 98% Zn, 1.5% Cu, .4% Pb and .1% Sn, (9) Everdur, an acid-proof Cu-Si alloy, (10) Helumin a light metal alloy containing 95% Al, 1.5-2% Cu, .5-1% Mn, .5% Sn and 1.5% metals of the Fe group, (11) Hibbo an English Fe bearing Al bronze, (12) Hiduminium a group of English complex Al alloys, (12) Hiorn metal a German Ag alloy with 46% Cu, 20% Zn, 34% Ni, (13) Hipernick an American electric resistance alloy, (14) Hohenzollern bearing alloy a German bearing alloy developed during the World War, (15) Erhardt's type metal a Zn rich substitute type metal used in Germany during the World War, (16) Eureka, a resistance alloy containing 55% Cu, 45% Ni, (16) Eutectal an Al rich light metal developed in France. GN (11a)

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Anti-Friction Metals; Their Composition, Structure, etc. *Commonwealth Engineer*, Vol. 20, July 1, 1933, pages 363-367. Sn-base and Pb-base anti-friction lining materials are considered with emphasis on their microstructure and of the fundamental properties of an anti-friction alloy. Considered entirely on their anti-frictional properties, the Pb-base babbitts appear superior to the Sn-base range. If a bearing is highly loaded in relation to its size, a high Sn-alloy is desirable, whereas for much slow speed work and less heavily loaded bearings, a Pb-base one may be employed and is more economical. 11 formulae covering the friction laws at high speed and frictional force at constant speed and constant load are set forth. WH (11a)

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The Conductivity of Copper Castings. Lyall Zickrick. *General Electric Review*, Vol. 37, Apr. 1934, pages 187-190. Deoxidation to insure sound castings often leaves residual elements in the Cu which harm the conductivity. Cleanliness and purity of the Cu are also important factors. Elements which combine with O_2 and are insoluble, or soluble in Cu only to a slight degree, produce the least effect upon electrical conductivity. Molten Cu will rapidly absorb O_2 from the atmosphere; care must be exercised in pouring the metal. Best conductivity results were obtained when calcium boride, calcium, or boron carbide were used. CBJ (11a)

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Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

The Physical Properties of Iron-Aluminium Alloys. C. SYKES & J. W. BAMPFYLDE. *Iron & Steel Institute, Advance Copy* No. 12, Sept. 1934, 22 pages; *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, pages 375-377 (abstract). Fe-Al alloys were prepared by melting low-C Fe or steel with commercial Al in high-frequency furnaces holding 10 lb. and ¼ ton. The Fe was melted, deoxidized with Fe-Si and Fe-Ti, fluorspar added, and then the Al added. In order to produce ingots with good surfaces the molds were filled with a material that would yield both C and Cl such as CCl_4 vapor; this prevented laps. Alloys containing more than 17% Al could not be worked at any temperature. Alloys containing 5% or less Al could be worked either hot or cold, and those containing from 5 to 16% Al could be worked hot but not cold. Mechanical properties of wrought alloys were determined. Alloys with 5% Al or less are ductile but all others were brittle as judged by the tensile test. The Brinell hardness increased to 286 at 12% Al; the Izod impact resistance fell from 103 ft.-lb. with 3.3% Al to 3 ft.-lb. with 7.6% Al. Short-time high-temperature tests were made. Alloys containing up to 5% Al were drawn into wire. Physical properties determined were coefficient of expansion, specific heat, density, thermal conductivity, and electric resistivity. Corrosion tests made with a salt-water spray and with boiler water showed that alloys containing between 10 and 15% Al were considerably more resistant to atmospheric corrosion than pure Fe. Resistance to oxidation at different temperatures was also studied. The results indicated that for freedom from scaling at 900 and 1000 °C. over 6% Al was required, at 1100 °C. over 9%, and at 1300 °C. over 11%. 8 references. JLG + Ha (11b)

Present State of Malleable Cast Iron Manufacture (Etat actuel de la Fabrication des Fontes Malleables). LEON GUILLET. *La Technique Moderne*, Vol. 26, June 1, 1934, pages 365-372; July 1, 1934, pages 445-452. In the 1st article, principles of manufacture of white heart and black heart malleables are explained as well as factors which are involved in the 2 types. Manufacture of black heart malleable is described at length and melting apparatus as well as annealing ovens are illustrated. It is pointed out that rotary melting furnaces are used more and more in the manufacture of malleable cast Fe. In the second article the author points out that properties of white heart malleable are much less known. He gives as follows properties on test bars of 10 mm. diameter: Tensile strength 35-40 kg./mm.². Elongation 2.5-3.5% on 75 mm. In the last section of the article, applications of the 2 types of malleable iron are reviewed. FR (11b)

Magnetic Behavior of Cold Rolled Iron-Nickel Alloys Due to Precipitation Hardening (Development of Isoperms) (Magnetisches Sonderverhalten kaltgewalzter Eisen-Nickel-Legierungen, durch Ausscheidungshärtung. (Entwicklung der Isoperme).) O. DAHL & J. PFAFFENBERGER. *Metallwirtschaft*, Vol. 13, July 27, 1934, pages 527-530, Aug. 3, pages 543-549, and Aug. 10, pages 559-563. The magnetic properties of Fe-Ni alloys, with and without the addition of Cu, were investigated in an attempt to find an alloy, for use in long distance telephony, whose permeability does not change with the strength of the field current. Such an alloy is called "isoperm." The alloys ranged from 90%Fe, 10%Ni to 35%Fe, 65%Ni, with Cu additions up to 20%. Permeability, coercive force, retentivity, electric resistance, and hardness were determined on the slowly cooled, quenched, and quenched and drawn alloys, after various degrees of cold working. The results are shown in numerous graphs. It was found that when the limit of solubility in the Cu-Ni-Fe system is passed, fundamental changes take place in the effect of cold working on the magnetic properties. These changes occur in all three conditions of heat treatment, but no unusual change in properties occurs in the quenched alloys when the solubility limit is passed if they are not subsequently cold worked. By varying the heat treatment, properties may be varied to suit the desired purpose. The best suited alloy is one consisting of a solid solution obtained by quenching, capable of being hardened by precipitation. Additions of Al, Ti, and Be, instead of Cu, were also investigated without promising results. Theoretical aspects of the magnetic changes and their relation to structural changes are discussed at length. The authors believe that the isoperm behavior is due to precipitation during cold rolling but state that absolute proof of this is still lacking. CEM (11b)

Steels for Die-casting Dies. SAM TOUR. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 568, Sept. 1934, 16 pages. The properties required in steels used for die-casting dies are discussed. Steels must be machineable, must not soften at too low a temperature, must have high resistance to heat checking, must have a certain hardness, must not be subject to cleavage cracking, must resist the solvent action of molten Al, must be clean, and must be reasonably priced. Properties at elevated temperatures are important because dies may be heated to 800-900° F. or higher. Results of laboratory tests on several die steels are given. Tests include hardness, impact resistance at elevated temperatures, and change in dimensions on heat treatment. Alloying elements in the steels tested include Si, Ni, Cr, W, Mo, V, and Co. A steel containing 0.34% C, 0.33% Mn, 0.96% Si, 5.11% Cr, 5.36% W, and 0.50% Co had high impact resistance at all temperatures. JLG (11b)

High-Quality Cylinder Gray Iron (Hochwertiger Zylindergrauguss). H. REININGER. *Automobiltechnische Zeitschrift*, Vol. 37, Sept. 10, 1934, pages 441-453. Requirements of cylinder castings, structure, chemical composition and treatment of the material are discussed. Cylinder castings should possess sorbitic or pearlitic structure in which little graphite in fine flakes is embedded. Ni and Cr may or may not be absent. P up to 1% is desirable in the form of steadite. The combined (C+Si) content for automobile cylinder blocks should be 4.8-5.3%. 93 references. Ha (11b)

Properties of Nickel Alloy Cast Irons and Their Special Application in Petroleum Production Equipment. O. B. J. FRASER & J. S. VANICK. *Oil Weekly*, Vol. 73, May 28, 1934, pages 32-42. Paper read before the Mid-Year Meeting of the American Petroleum Institute, Division of Production at Pittsburgh, May 23, 1934. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 494. Kz (11b)

Ageing Changes in Nitrided Steel. EDWARD G. HERBERT. *Iron & Coal Trades Review*, Vol. 129, Aug. 3, 1934, page 159; *Engineering*, Vol. 137, June 29, 1934, page 745; *Iron & Steel Industry*, Vol. 7, June 1934, page 307. From paper read before the Iron and Steel Institute, June 1934. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 358. Ha+LFM+CEJ (11b)

Some Effects of Cold-Rolling on the Intergranular Corrosion of the 18-8 Stainless Steels. E. C. ROLLASON. *Engineering*, Vol. 138, Aug. 3, 1934, pages 131-132; *Iron & Steel Industry*, Vol. 7, June 1934, pages 303-304. From paper read before the Iron & Steel Institute, June 1934. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 458. LFM+CEJ (11b)

Conductivity of Pure Iron. *Engineer*, Vol. 157, June 22, 1934, page 638. Brief comment on paper read by R. W. Powell before the Physical Society, June 15, 1934. LFM (11b)

Magnetic Materials. I. C. PETTIT. *Bell Laboratories Record*, Vol. 13, Oct. 1934, pages 39-44. Description of characteristics of magnetic materials required for electric machinery, telephone and telegraph apparatus, as determined by composition. Ha (11b)

Some Experiments on Rolling Carbon and Manganese Steels with Improved Mechanical Properties. K. F. STARODUBOV. *Domez*, No. 5, 1934, pages 8-16. (In Russian). Steel of SAE 1055 type, in the hot rolled state, showed wide variation in physical properties. Normalizing solved the problem. Heats with 0.35-0.50% C and 1.3-1.6% Mn gave promising results with regard to mechanical properties. (11b)

Heat Treatment for Grain Size in Cast Steel. C. E. SIMS. *Metal Progress*, Vol. 26, Sept. 1934, pages 22-27. Fine grained castings are found to be tougher than coarse grained castings although the latter are more readily machinable. Toughness may be adversely affected by improper heat treatment. WLC (11b)

Alloy Steels. Classification and Uses (Les aciers spéciaux. Classification et emplois). L. PERSOZ. *Génie Civil*, Vol. 105, Aug. 1934, pages 165-168, 185-190. Summary of the properties of alloy steels. Changes produced by addition of given elements are emphasized. JDG (11b)

Iron-Cobalt Alloys. G. A. KELSALL. *Bell Laboratories Record*, Vol. 13, Sept. 1934, pages 10-11. Fe-Co alloys with 50% Co show particularly good magnetic properties but are too brittle for cold-rolling into thin sheets. Addition of not more than 2% V improved mechanical properties without impairing magnetic qualities. Ha (11b)

Selecting Alloy Steels for High-Temperature Service. *Product Engineering*, Vol. 5, Oct. 1934, pages 384-385. It is pointed out that properties at normal temperatures are usually not indicative of high-temperature properties. Characteristics of alloy steels with Ni, Cr and Mo are given in curves. Ha (11b)

The Effect of Alloying Metals on Gear Steels. *Machinery*, N. Y., Vol. 41, Sept. 1934, page 17. Brief review of properties imparted to steel by Ni, Cr, Mn, V, Mo, Cr-Ni, Cr-Mo, Ni-Mo, with particular reference to their effects in gear steels. Ha (11b)

Non-Corrodible Steel Aerial Wire. *Iron & Coal Trades Review*, Vol. 129, Sept. 28, 1934, page 459. The (British) Air Ministry specifies, for the manufacture of aerial wire, a steel of max. 0.05% S, max. 0.05% P, not less than 6% Ni, and not less than 12% Cr; W, Ti, Mo, Cu and V may be present. The diam. shall be not less than 0.0145 in. and not more than 0.0155 in. Testing and packing rules are described. Ha (11b)

The Bearing Value of Rollers. WILBUR M. WILSON. *University of Illinois Bulletin*, Vol. 31, Feb. 13, 1934, pages 3-32. The load-carrying capacity of small rollers similar to those used as expansion rollers of girder and truss bridges was investigated. The bearing value is arbitrarily defined as the load which produces a plastic flow of 0.001 in. per in. when the roller is rolled 1000 strokes. Tables of bearing load for different diameters and curves showing relation between strength of the material and bearing value are given. Ha (11b)

Cast Crankshafts for Automobile Motors (Vilebrequins coulés pour Moteurs d'Automobile). *Revue de Fonderie Moderne*, Vol. 28, Aug. 25, 1934, pages 241-244. Comparison with forgings, made of molding and casting, and heat-treatment of an alloy steel for crankshafts (of Ford V-8 automobiles) containing 1.25-1.40% C, 0.5-0.6% Mn, 1.9-2.1% Si, 0.35-0.40% Cr, 2.5-2.75% Cu, and maximum 0.10% P and 0.06% S is described. Brinell hardness of the finished crankshaft is 269-302 as compared to 220 for forged crankshafts before machining and heat-treating. Ha (11b)

Low Nickel—Chromium Steels (Les Aciers au Nickel-Chrome à Basses Teneurs). LÉON GUILLET. *La Technique Moderne*, Vol. 26, Aug. 1, 1934, page 533. Points out that alloying elements increase the depth of hardening in quenched material and explains that a steel having a composition of C 0.25-0.45%, Ni 1.50%, Cr 0.70-0.90%, Mn 0.80%, Si 0.25%, although less expensive than steels containing 3.5% Ni and 1.5% Cr, gives good results after heat treatment in small sections, (20-30 mm. diameter). FR (11b)

Steels With Up to 7% Chromium. S. M. NORWOOD. *Metal Progress*, Vol. 26, Sept. 1934, pages 17-21, 56. Low cost of Cr compared with other high grade alloy additions makes its alloys of considerable interest. Good properties of Cromansil steel has led to much interest in Cr. Plain Cr steels with up to 7% Cr develop certain desirable properties with a simple heat treatment such as air hardening from 1625° F. 1-3% Cr group has high tensile properties and wear resistance. 4-6% grade with or without additions of Mo, W or Ti offers a very satisfactory heat and corrosion resistant alloy of low cost for oil refinery service. Ti addition eliminates the air hardening feature thus avoiding costly annealing treatments for machining purposes. The Ti addition improves oxidation resistance while the creep values are as good as in the plain alloy. WLC (11b)

Causes of Changes of Length in Invar Wires (Über die Ursachen der Längenänderung von Invardrähten). F. NEUMANN & H. JOHANNSEN. *Zeitschrift für Instrumentenkunde*, Vol. 54, June 1934, pages 173-190. The gradual longitudinal dimensional changes observed on invar wires is ascribed to (1) structural changes and (2) due to accidental bends. The stress conditions at bends are discussed theoretically and checked experimentally. Bends of 0.4 mm. could be eliminated. In the case of larger bends an additional bend entails permanent deformation which results in hysteresis phenomena. Instructions are given as to how to pre-stress invar wires before use and methods of improving invar wire measurements are pointed out. EF (11b)

The Influence of Vanadium on Carbon Steel and on Steels Containing Nickel and Chromium. H. H. ABRAM. *Iron & Steel Institute, Advance Copy* No. 1, Sept. 1934, 25 pages. Influence of 0.4 and 0.7% V on the properties of plain C and alloy steels was studied. The alloy steels included Cr and Ni-Cr steels containing various amounts of these elements. The steels were crucible melted. Inverse-rate heating and cooling curves indicated that V raised the A_3 point and had an uncertain effect on the A_1 point. V steels showed secondary hardness on tempering the quenched material in the neighborhood of 600°C. This is attributed to the separation of V_4C_3 on tempering. The temper hardening lowers impact resistance. Only 0.35 or 0.4% V is needed to secure full benefit of temper hardening. The addition of V increases hardness of quenched C and low-alloy steels such as 0.65% Cr steel. It does not increase hardness of quenched steels of higher alloy content, but has a marked influence on the hardness of steels cooled at a slower rate than that obtained with a liquid quench. JLG (11b)

The Properties of Non-hardenable Alpha-iron Steels. S. H. REES. *Iron & Steel Institute, Advance Copy* No. 10, Sept. 1934, 23 pages. Fe-rich alloys that were not entirely austenitic at any temperature, containing Si, P, W, Mo, or V, were prepared. Most of them contained about 0.10% C. The alloys were hot rolled. Some were then cold rolled and subsequently annealed at different temperatures. Tensile properties, hardness, and impact resistance were determined. Elongation was very low for most of the alloys but even those with high elongation had extremely low Izod impact values. Cold rolling, when it could be successfully carried out, increased the yield point and tensile strength, while subsequent annealing at low temperatures raised the proportional limit appreciably. In this manner Fe-W and Fe-Mo alloys with a yield point of over 40 tons/in.² and over 20% elongation were produced, but the Izod impact resistance was only 2 or 3 ft.-lb. 7 references. JLG (11b)

Influence of Magnetic Fields on the Mechanical Hardness of Metals and Alloys (Einfluss von Magnetfeldern auf die mechanische Härte von Metallen und Legierungen). A. SCHULZE. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 8, 1934, pages 1069-1070. A critical review of investigations dealing with the question of whether hardness is affected by magnetic fields. Concludes that, at present, no definite answer can be given. Changes of hardness observed by some authors seem to be due to causes other than magnetic effects. Ha (11b)

No automobile part carries greater responsibility than the steering knuckle. Steel for this severely-stressed, vital part must have strength and ductility—and more. Above all else, bars and billets must be absolutely sound and free from surface defects that, on account of the intricacy of the forging, might cause hidden points of weakness.

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Alloy Steel Castings in Use in America. A. W. GREGG. *Iron & Coal Trades Review*, Vol. 129, Aug. 24, 1934, page 267. Notes on specifications for mechanical properties, manufacture and heat-treatment of the 15 most widely used pearlitic and sorbitic types of alloy steel castings. These castings are used in applications in which (1) increased strength for a given ductility, (2) increased ductility for a given strength, (3) increased resistance to wear and abrasion and (4) increased shock resistance is required. Ha (11b)

Notch Sensitivity of Cast Iron (Beitrag zur Kerbenempfindlichkeit von Gusseisen). JULIUS BACH. *Die Giesserei*, Vol. 21, Aug. 17, 1934, pages 342-345. Static tests with differently shaped notches showed a reduction in tensile strength, as compared to the un-notched (3000 kg./cm²), amounting to 25% for a notch of 3 mm. radius and 14% for 12 mm. radius notch. Ha (11b)

Low Carbon Ni-Mn Austenitic Cast Iron (Etude de Quelques Proprietes Physiques d'une Fonte Austenique au Ni-Mn a Basse Teneur en Carbone). GEORGES R. DELBART & EDGAR LECOEUVRE. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, No. 7, pages 279-288; *Usine*, Vol. 43, Aug. 2, 1934, page 30. Paper presented at the Foundry Congress in Nancy, July 1934. The metal studied had the following composition, Si 1.81%, S 0.025%, Mn 3.75%, Ni 6.50%, P 0.074%, T. C. 2.65%. Various heat treatments were tried. The structure was austenitic but readily changed to martensitic. The metal had high elastic modulus, high elastic limit and high permanent deformation. Ha + WHS (11b)

Influence of a Second Alloying Metal on the Properties of Copper Alloy Steel (Einfluss eines zweiten Legierungsmetalles auf die Eigenschaften kupferlegierten Stahles). GERHARD SCHMIDT. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 1, 1934, page 1045. Recent investigations into the influence of Ni, Cr, Mo, V, Co or Ti to steels with 0.5-1.5% Cu and a C content of 0.07-0.29% are reviewed. The results of Rädeker (see *Metals & Alloys*, Vol. 5, May 1934, page MA 221) are briefly described and the 1st Report of the Corrosion Committee of the Iron & Steel Institute (see *Metals & Alloys*, Vol. 3, May 1932, page MA 119) is cited. Ha (11b)

Steels for Heat-Treated Gearing. T. R. RIDEOUT. *Heat Treating & Forging*, Vol. 20, June 1934, pages 291-296. **Selecting the Right Steels for Heat Treated Gears.** *Steel*, Vol. 94, June 11, 1934, pages 48, 50-51. **What Properties are Expected in Steels for Gears?** *Machinery*, N. Y., Vol. 40, Aug. 1934, pages 739-741. See *Metals & Alloys*, Vol. 5, Aug. 1934, page 416. MS + Ha (11b)

Alloy Steels (Die Edelstähle). F. RAPATZ. 2nd Edition. Julius Springer Verlag, Berlin, 1934. Cloth, 5½ x 8½ inches, 386 pages. Price 22.80 RM. The notable progress in alloy steels since the appearance of the first edition 10 years ago has required the entire rewriting of the book. This edition not only deals with the automotive type of structural steels and with high speed steels, which were the features stressed in the first edition, but includes discussion of hardenability and abnormality of carbon steels, evaluation of an alloying element's effect by its influence on the critical quenching rate, weldability, machinability, endurance properties, high temperature properties, etc. The various alloy steels and their properties are described in concise form under each alloying element, a paragraph or more being devoted to each important step in composition. Among the many features that demand attention today on which little or nothing could be said ten years ago are the copper steels of the "Stahl 52" series, nitriding steels, the tungsten carbide type of tools, and a huge mass of information on corrosion resistant and heat-resistant steels. With so wide a field to cover, very detailed treatment cannot be expected. Some of the discussions would fail to give a clear or adequate idea of the topic covered, to the novice reader, but the experienced one will find the marshalling of much information into a rather coherent whole very much worth while. Most topics have references to important literature, though, of course, space is lacking for anything approaching complete bibliographic treatment, and German references predominate. The book is of interest as indicating German commercial practice as well as for the direct information it contains. From the omission of special comment it would appear that the 5% Cr steels and the use of nitrogen to refine the grain in high-Cr steels have not yet impressed German metallurgists as much as they have those here. The comment is made that outside of screw stock, S and P are always undesired impurities. The P content of "Cor-Ten" shows that American metallurgists do not entirely agree with this. A very difficult task of compression has been accomplished in giving in so small a space so nearly adequate a discussion of alloy steels, from those with but a few tenths of a per cent of alloy up to those so highly alloyed as to make it a question whether they can properly be termed steels. The volume is well printed, bound and indexed. While it will seldom give sufficient detail to make it the only source of information that has to be consulted in looking up a matter within its field, it will be a very good starting point, and well deserves being added to the book shelf of the steel metallurgist. H. W. GILLETT. (11b)—B—

Physical Investigations on New Magnetic Materials (Physikalische Untersuchungen an neuen magnetischen Werkstoffen). M. KERSTEN. *Zeitschrift für technische Physik*, Vol. 15, No. 7, 1934, pages 250-256. The new magnetic materials of the "isoperm" type have high magnetic stability combined with high permeability and low losses; they are mostly used in apparatus for telephone transmission lines. Certain alloys, for instance 45% Ni, 55% Fe to which 9, 12 or 15% Cu is added, are susceptible to precipitation after severe cold rolling in which case they show an abnormally low remanence; this is attributed to a preferred magnetic position or arrangement of the molecules vertical to the direction of rolling. The origin of such arrangements is discussed. 17 references. Ha (11b)

Combating Sulphur in Cast Iron (Die Bekämpfung des Schwefels im Gusseisen). CARL REIN. *Die Giesserei*, Vol. 21, July 6, 1934, pages 283-287. The effects of S in Fe are discussed with particular reference to practices before and after the war which changed melting operations due to economic conditions. The accumulation of S in Fe during melting depends on S content of coke, surface and coarseness of ore in the charge, smaller pieces taking up more S than large pieces, on the location of the melting zone in the furnace, a furnace with low melting zone is more favorable than one with a melting zone extending far up, and on the addition of steel and materials with low C content which increase the S in the product. Proper composition and selection of materials are discussed. Ha (11b)

Investigations of the Change of Some Properties (α-γ- Transformation, Hardness, Electric Conductivity, Magnetic Properties) of Iron-Chromium-Nickel and Iron Chromium-Molybdenum Alloys by Heat-Treatment (Untersuchungen über die Aenderung einiger Eigenschaften (α-γ- Umwandlung Härte, elektrische Leitfähigkeit, magnetische Eigenschaften) von Eisen-Chrom-Nickel-und Eisen-Chrom-Molybdän-Legierungen durch Wärmebehandlung). KL. BISCHOFF. *Mitteilungen aus dem Forschungsinstitut der Vereinigte Stahlwerke Aktiengesellschaft Dortmund*, Vol. 3, No. 9, Oct. 1933, pages 249-266. The stability of austenite, upon which resistance to corrosion depends and the possibility of producing rust-proof steels which can be hardened by precipitation processes was investigated. Cr-Ni steels within the (thermal) hysteresis range remain thermodynamically unstable even for very long annealing times. A magnetically detectable transformation can be effected in austenitic Cr-Ni steels by cold-working below a certain temperature. The beginning of transformation is shifted by rapid quenching; the change of (magnetic) hysteresis is very small. Precipitation hardening of the Fe-Mo and Fe-W alloys is obtained over a wide range when Cr is added; hardness and magnetic properties of such precipitation-hardened Fe-Cr-Mo and Fe-Cr-W alloys reach very high values. A constitution diagram of the saturation area of Fe-Cr-Mo alloys was developed up to 30% Cr. Addition of Mo to Fe-Cr-W alloys produced great hardness and good magnetic properties. 32 references. Ha (11b)

EFFECT OF TEMPERATURE ON METALS & ALLOYS (12)

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Heat Resistance of Grate Castings (Beitrag zur Feuerbeständigkeit von Rostguss) R. ZEH & E. PIWOWARSKY. *Die Giesserei*, Vol. 21, Sept. 14, 1934, pages 385-388. Owing to increasing demands on boiler grates, experiments were made to find the best kind of cast Fe for a grate. P content has a considerable influence on the durability; 0.4-0.5% seems to be the best. Total C content is of utmost importance. Low C castings (less than 2.6% C) c'd not stand up well under fire, and small additions of Ni, Cr and Mo had no appreciable effect. But in castings with 3.2-3.4% C such additions increased durability 3 to 4 times. P content of castings was not reduced during service but did tend to change the structure in time; S content increased to 2 and 3 times the original value. Results of tests are described in detail. Ha (12)

The Influence of Silicon and Aluminum on the Resistance of Cast Iron to High Temperatures. M. H. THYSSEN. *Iron & Steel Institute. Advance Copy* No. 13, Sept. 1934, 56 pages; *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, pages 373-375 (abstract). Irons containing high Si, Al with normal Si, and both high Si and Al were prepared by casting into green-sand molds. Castability, mechanical properties, and structure of each iron were determined. Deterioration at high temperatures was studied by dilatometric measurements and weight increments of samples heated in air, in fine sand, and in an atmosphere high in S. Only those alloys near the eutectic had satisfactory castability and mechanical properties. Hypereutectic alloys were entirely unsatisfactory. For the high-Si irons one with 5.5% Si and 2.5% C appeared to be the best industrial material for high-temperature service. Irons with high Al and normal Si were resistant to deterioration or corrosion at high temperatures but their mechanical properties were unsatisfactory. Irons with Si and Al both high had good mechanical properties and a high resistance to elevated temperatures provided C was in the neighborhood of 2%. 12 references. JLG + Ha (12)

Experiences with Plants Operating at 600° C. Steam Temperature (Erfahrungen mit Wasserdampfanlagen für 600° Dampftemperatur). GERHARD FRIEDEWALD. *Die Wärme, Zeitschrift für Dampfkessel & Maschinenbetrieb*, Vol. 57, June 2, 1934, pages 352-354. Discusses practical experience gained by Thompson & van Duzer on various corrosion and heat-resisting steels tentatively utilized in the Trenton Channel and Delray Plants. Analyses of the 11 steels employed, physical properties, application and results of inspection are summarized in 4 tables. No difficulties are seen in the construction of a power plant operating at 540° C. steam temperature. However the high price of the present structural materials renders the erection of such a plant uneconomical. In disagreement with the favorable comment of Thompson & van Duzer on 18/8 the author calls attention to the failures of continental 18/8 superheater tubes particularly at welded joints. The tendency in Germany is to replace the expensive 18/8 as boiler material by cheaper lower alloy steels. EF (12)

Belgian Research Committee on the Behaviour of Metals at Elevated Temperatures. Some Results Obtained During the First Campaign of Research (January, 1932—January, 1934). Testing Methods. Special Apparatus. H. DUSTIN. *Iron & Steel Institute, Advance Copy* No. 2, Sept. 1934, 15 pages; *Iron & Coal Trades Review*, Vol. 129, Sept. 14, 1934, pages 369-370. Experience with a number of accelerated methods for determining creep resistance indicated that such methods were unsatisfactory. Equipment was built for long-time tests (1000 hr. or more). In the newly constructed equipment elongation is measured by a special extensometer of the Martens type. Each machine holds two specimens, both specimens being in the same furnace. Each furnace is wound with 3 windings. A photoelectric cell operated by a beam of light reflected from a galvanometer mirror is used to regulate the temperature. The photoelectric cell actuates a Thyratron, which operates a relay that changes the current in the furnace windings. JLG+Ha (12)

Resistance of Materials at High Temperatures (La Résistance des Matériaux à Haute Température). H. J. TAPSELL. *Science et Industrie (Métaux et Machines)*, Vol. 18, June 1934, pages 168-172. First section describes the method developed at the National Physical Laboratory for determining creep and the "limiting creep stress." Then the usual testing method used in America is explained. A special part is devoted to the estimation of total deformation and the last section is devoted to accelerated methods for measuring creep characteristics of metals. FR (12)

Methods for Corrosion Study of Metals and Alloys in Gases at Elevated Temperatures and Their Application (Méthodes d'études de la corrosion des métaux et alliages par les gaz à température elevée et leurs application). A. PORTEVIN, E. PRETET & H. JOLIVET. *Chaleur et Industrie*, Vol. 15, Mar. 1934, pages 167-199. Paper read at the 3d Congress of Industrial Heating, Paris, Oct. 10-14, 1933. See *Metals & Alloys*, Vol. 5, Sept. 1934, page MA 460. FR (12)

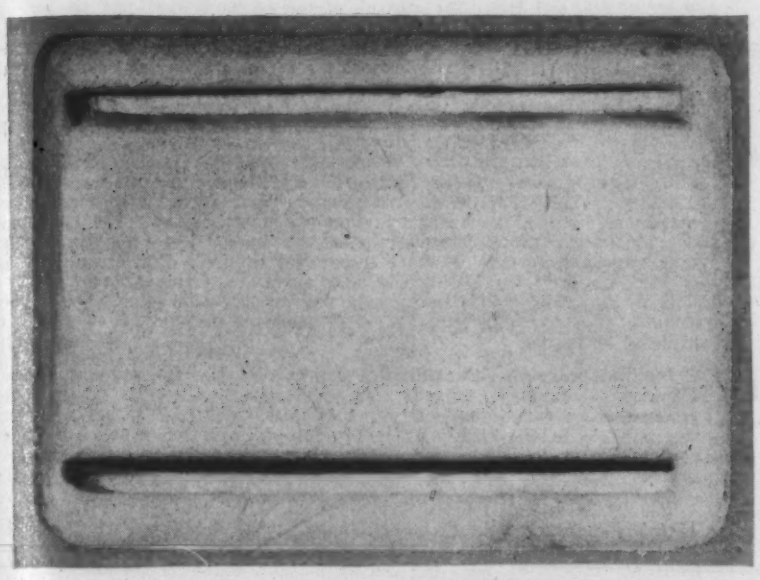
Torsional Moduli Variations of Spring Materials with Temperature. JOSEPH W. LUDEWIG. *Transactions American Society for Metals*, Vol. 22, Sept. 1934, pages 833-860. Data are presented on the variations of the torsional moduli of various spring materials from which it is found that materials maintaining highest absolute value of this modulus up to 450° F. are high speed steel, stainless steel and Konel alloy, (Ni 46%, Co 25%, Fe 7.5%, Ti 2.5%, Cr 19%); that at 985° F. high speed steel maintains the highest absolute value; and that C spring steel has the lowest absolute value of modulus at all temperatures. The factors found in spring formulae and their behavior under temperature variations are discussed. 15 references. WLC (12)

Temperature Dependence of the Elastic Limit of Metals Near the Melting Point. V. D. KUZNETZOW & N. A. NOLSHANIA. *Physikalische Zeitschrift der Sowjet Union*, Vol. 5, 1934, pages 31-39. The indentations of a 25 mm. steel ball in dependence on temperature were measured on Sn, Bi, Zn and Cd. Approaching the melting point of these metals, the diameter of the impressions approached the ball diameter thus proving that the elastic limit becomes zero near the melting point. EF (12)

Adsorption (Über Adsorption). ARNOLD KEMPER. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 169, July 1934, pages 275-286. It has been experimentally proved that Ni and Ag wires lose most of their adsorption power on heating. This is ascribed to the fact that peaks ("Spitzen") and defective spots of the space lattice ("Störungstellen") possess particularly great adsorption abilities. On heating the peaks are leveled out and defective lattice spots heal out, thus reducing the adsorption power. Ni and Ag wires were heated in N_2 at pressures of from .1-750 mm. Hg and slowly cooled. No effect of N_2 upon this phenomenon could be observed. In comparison with Ag, the adsorption power of Ni during the early stages of heating is much lower due to the higher melting point of Ni. Etching of the heat-treated metals partly restores their adsorption power which drops again on reheating. The adsorption loss increases with rising annealing temperatures. After long-time annealing at elevated temperatures, the thickness of the adsorbed surface layer is below the size of a mono-layer. This experimental result is in disagreement with Langmuir's theory that saturation is connected with the formation of a mono-layer. EF (12)

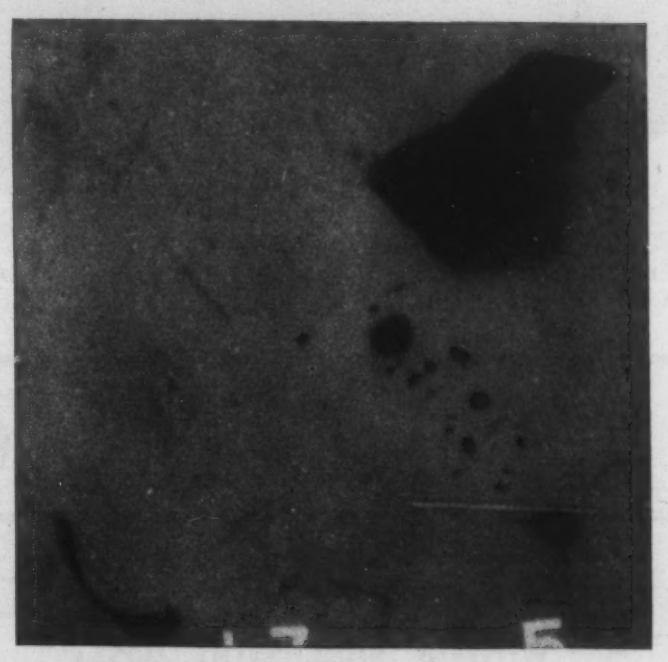
DISCLOSED BY
THERMALLOY
"X-RAY INSPECTION"

A Casting which *Ordinary Visual* Inspection would appraise as satisfactory.



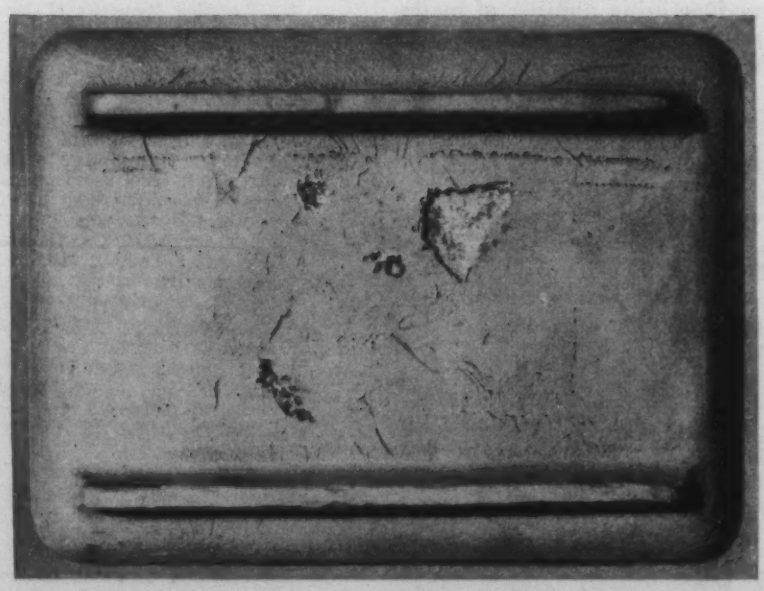
Unretouched photograph of bottom of Carburizing Box

A Thermalgraph of *Same* Casting



Radiographic View

SAME CASTING
After
Fracturing Defective Areas Disclosed by X-Ray



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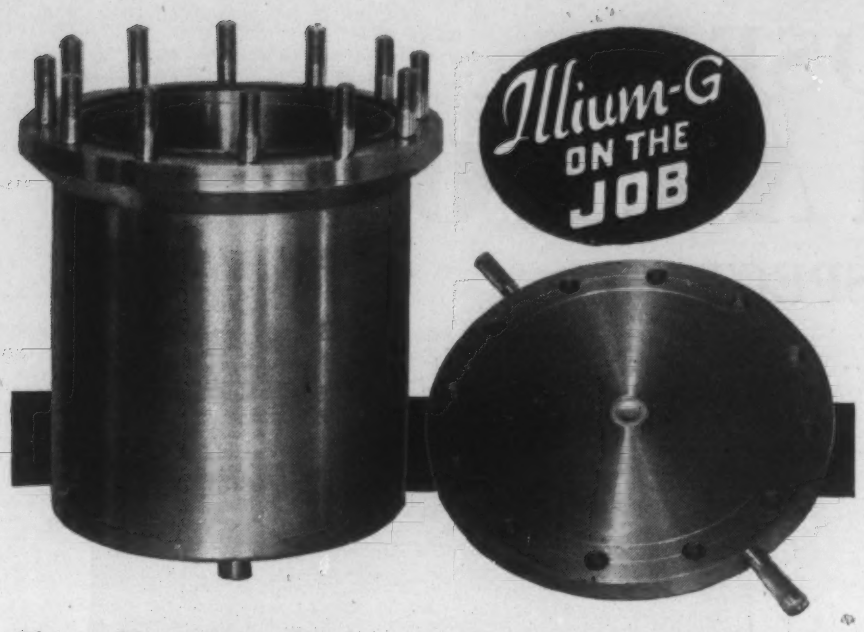

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CORROSION & WEAR (13)

V. V. KENDALL, SECTION EDITOR

1 **The Blistering of Iron Oxide Scales and the Conditions for the Formation of a Non-adherent Scale.** R. GRIFFITHS. *Iron & Steel Institute, Advance Copy* No. 4, Sept. 1934, 8 pages. Blistering of scale may occur at temperatures between 850° and 1050°C. The presence of an inert gas is necessary. The presence of water vapor in sufficient amounts in the oxidizing atmosphere of the furnace prevents blistering. By the addition of steam to 0 or air, under certain conditions, the surface of Fe or steel after removal of the scale is clean and free from oxide. Conditions governing the formation of a non-adherent scale are discussed. JLG (13)

Propeller Cavitation Studies. C. O. KELL. *Engineering*, Vol. 138, July 27, 1934, pages 102-103. From paper read before the Institution of Naval Architects, July 11, 1934. LFM (13)

2 **Acid Corrosion of Industrial Iron in Presence of Sulphur Dioxide (Die Säurekorrosion des technischen Eisens in Gegenwart von Schwefelsäureanhydrid, SO_2).** W. A. KARNITZKIJ & N. A. GOLUBEW. *Korrosion und Metallschutz*, Vol. 10, Aug. 1934, pages 190-195. Studying the pickling process of Fe in H_2SO_4 or HCl it was found that corrosion is accelerated considerably in the presence of dissolved gases of SO_2 and H_2S. The strength of the action is the same for both gases in HCl, but in H_2SO_4 a stronger action is exerted by SO_2. The acceleration of corrosion velocity of Fe depends on the H-ion concentration; maximum acceleration occurs at 30% H_2SO_4. The accelerating effect of these gases can be explained by the formation on the surface at different places and with different velocity, of FeS films which account for a great number of local elements entering into the metal. Ha (13)

3 **The Deterioration of Lashing Chains in Service.** A. HUDSON & W. A. JOHNSON. *Transactions of the Institution of Mining Engineers*, Vol. 87, June 1934, pages 140-152. Most of the surface hardness developed during the initial months of test and is attributable to abrasion and impact. The interior hardness due to strain developed more slowly and uniformly. Where the hardness exceeded 260, structural deformation of the surface was observed. This occurred on the sides of the links near the lashing end after about 3 months. Mean hardness of the interior was about 160. In no case was crystal deformation observed beyond a depth of 0.02 in. Annealing at 690° produced recrystallization in wrought Fe hardened by impact. AHE (13)

4 **The Reaction of Sodium with Dry Oxygen.** B. L. HERRINGTON. *Journal of Physical Chemistry*, Vol. 38, May 1934, pages 675-682. It remains to be proven that O_2 can be made so dry that it will not react with Na. Na-amalgams were exposed to O_2 dried over phosphorous pentoxide for more than a year, the amalgams were instantly covered with a protecting film which prevented further action. EF (13)

5 **Why Do Some Metals Resist Oxidation?** K. HEINDLHOFER & B. M. LARSEN. *Metal Progress*, Vol. 26, Sept. 1934, pages 34-37. Factors affecting the formation of protective oxide film oxidation of metals are dissociation of metal oxide at temperature less than partial pressure of O_2 in atmosphere in contact, non-volatile oxide, and heat of oxidation which will not melt the oxide. Noble metals do not oxidize at all because the partial pressure of O_2 from their oxides is so high that they immediately decompose. Ni in steel provides some protection by reason of its greater resistance to oxidation but very large quantities are necessary as Fe oxidizes in preference to Ni and Fe oxides undermine the Ni. Cr oxidized more rapidly than Fe and is consequently oxidized first and the oxide formed is adherent and impervious to diffusion and thus inhibits oxidation. WLC (13)

Corrosion Resistant Alloys (Alliages Résistants à la Corrosion). GUITTON. *Usine*, Vol. 43, July 19, 1934, page 35. The various theories explaining corrosion phenomena are discussed and their practical application for producing corrosion resistant materials by proper composition, structure and treatment (rustless steels, Cr-cast iron, non-ferrous alloys) are reviewed. Ha (13)

6 **Corrosion Properties of Bronzes (Korrosionsfestigkeit von Bronzen).** O. DAHL. *Oberflächentechnik*, Vol. 10, Dec. 19, 1933, page 282. See *Metals & Alloys*, Vol. 5, July 1934, page MA 366. Ha (13)

Theory of Plasticity and Danger of Rusting (Plastizitätstheorie und Rostgefahr). R. BORTSCH. *Beton & Eisen*, Vol. 33, July 20, 1934, pages 220-222. The author points out the regions where undue overstressing of Fe reinforcements in reinforced concrete takes place. The danger of rusting increases with steels which are under high stresses or which have been previously submitted to pre-stresses. Recently it could be shown that the flow lines on polished steel under tensile stress in acid also show up below the elastic limit. A potential difference between the cold worked regions and less affected parts occurs. The author reports on tests which determined the loss of corrosion resistance of steel due to cold working. 7 The excess Ca-hydroxyde passifies structural steel in reinforced concrete unless there are large cracks and gaps. EF (13)

Rubber as Protection from Corrosion of Ship Propeller Shafts (Gummi als Korrosionsschutz bei Schiffsschraubenwellen). *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Sept. 15, 1934, page 1091. Calls attention to the protection from corrosion which can be obtained for those parts of propeller shafts outside the ship's hull exposed to sea water and stray electric currents by a layer of vulcanized rubber. A thickness of 6 mm. is sufficient, the layer must be very intimately joined to the surface. Vulcanizing methods are briefly described. Ha (13)

8 **A New Corrosion-Resisting Material for the Chemical Industry (Ein neuer korrosionsbeständiger Werkstoff für die chemische Industrie).** *Werkstoffe und Korrosion*, Vol. 9, July 25, 1934, page 26. A new alloy, "Corrix Metal," consists of 88.1% Cu, 8.7% Al, 3.05% Fe, and has in cast state a tensile strength of 55-65 kg./mm.² with an elongation of 20-30%. It can be rolled, pressed, forged, drawn, hardened and welded, and has a very fine grain structure. Corrosion resistance is equal and even superior to austenitic Cr-Ni steels. HCl, 50% acetic acid, thiosulphate and ammonium chloride attack it somewhat in the beginning but this soon ceases and a state of equilibrium is formed. It resists almost all organic and inorganic acids and alkalis. It is used in chemical plants where it comes in contact with ammonia. A list of chemicals and loss of weight when exposed to them is added. Ha (13)

9 **Metal Coatings as Corrosion Protection for Iron (Metallbeläggningar som korrosionsskydd paa järn).** *Teknisk Tidskrift* (Section *Bergsvetenskap*), Vol. 64, July 14, 1934, page 57. A discussion by Sven Danieli of the article by Sven Brennert under the above title, which appeared in the May 12 issue. (See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 498). He states that the corrosion resistance of a zinc coating does not only depend on its thickness, but also upon whether it is applied by hot-dipping or by electrolysis. Two galvanized steel plates were prepared, one with an electrolytic coating of 200 g./sq.m. Zn, the other hot-dipped, 332 g./m.² Zn. These were joined along one edge by flashing and then exposed to the weather for 2 years, after which time the hot-dipped piece showed distinct signs of rusting along the flashed edge, while the other was unaffected. When not joined together neither gave any evidence of rusting 10 after the same time of exposure. BHS (13)

Interior Corrosion of Zn (Corrosion Intérieur du Zinc). E. ARENDT. *Comptes Rendus*, Vol. 199, July 9, 1934, pages 142-143. If passive zinc is placed in H_2SO_4 or HCl solution for several weeks, corrosion occurs in interior of metal due to difference in chemical properties of superficial passive film and interior of metal. FHC (13)

Phosphate Rust Protection of Iron, With Particular Reference to Patent Literature (Der Phosphatrostschutz des Eisens unter besonderer Berücksichtigung der Patentlitteratur). E. RACKWITZ. *Korrosion und Metallschutz*, Vol. 10, Mar. 1934, pages 58-68. Protection of Fe from rusting by a layer of phosphate which is produced on the surface of the Fe as a fine-crystalline, thin, uniform coating, is reviewed and chronological development and patent literature cited. Ha (13) 1

The Weathering of Aluminum Alloy Sheet Materials Used in Aircraft. W. MUTCHLER. *Report No.* 490, *National Advisory Committee for Aeronautics*, 1934, 35 pages. Sold by Supt. of Documents, Washington, D. C. Price 15 cents. Summary of study of causes for and prevention of intercrystalline embrittlement of duralumin carried on by the Bureau of Standards since 1923, by laboratory tests and prolonged exposure tests at several locations. Progress reports by H. S. Rawdon have appeared from time to time as N. A. C. A. Technical notes. This summarizes the work, which is outstanding in that an accelerated laboratory corrosion test, by alternate immersion in a $NaCl$-H_2O_2 solution, led to conclusions entirely compatible with the exposure tests. Cold water quenching was the most important factor in preventing intercrystalline attack. Slight cold working has no important effect. A pure Al coating, as in Alclad, defeats attack on weather exposure. Al pigmented spar varnish over a surface that has been anodized in chromic acid gave considerable protection. These precautions and protective measures make duralumin a dependable material for aircraft construction. Much information on rate of deterioration in wrongly-quenched material, on the relative rate of attack at various locations, e.g. Washington and Coco Solo, the behavior of materials of varying composition and on the mechanism of intercrystalline attack, is included. The article is a concise account of an investigation that has meant much for the progress of aeronautics. HWG (13) 2

Corrosion of a Coke Scrubber (Korrosionserscheinungen an einem Koksskrubber). E. ALTMANN & R. SCHOLZE. *Die Wärme, Zeitschrift für Dampfkessel & Maschinenbetrieb*, Vol. 57, June 2, 1934, pages 358-359. Local corrosion starting from the inside of a coke scrubber in the middle section led to failure due to complete puncture. The source of trouble is ascribed to electrolytic action due to the formation of galvanic cells consisting of Fe shell, coke and acid water. The corrosion defects are illustrated and the mechanism of the electrolytic action traced. By using an additional insulation layer at the inside, the corrosion attack could be stopped entirely. EF (13) 3

The High Cost of Caustic Embrittlement. *Locomotive*, Vol. 40, July 1934, page 77. Caustic embrittlement in boiler plants has caused a damage of about $4,000,000 since its discovery in 1930; statistics of the U. S. A. are given. Embrittlement was never found where feed water was treated so that the sodium carbonate-sodium sulphate alkalinity ratios corresponded to those recommended by the A.S.M.E. Boiler Code. Ha (13) 4

Anti-Corrosive Centrifugal Pumps. The Use of Special Alloys. *Dyer, Calico Printer, Bleacher, Finisher & Textile Review.* Vol. 71, Mar. 30, 1934, pages 363-364. Discusses the utilization of Monel metal, Si-bearing Fe, stainless steels and corrosion resistant bronze in the manufacture of pumps. A table gives percentage losses after boiling a Si-bearing Fe for 24, 48, and 72 hours in some 17 chemical reagents. The heat resistant steels discussed include 18/8 with various special additions, 25/11 and 26/12 Cr-Ni steels. An Al bronze with 87.5% Cu, 7.5% Al, 3.5% Fe, balance Mn is claimed to be forgeable, machineable, of good tensile strength and especially resistant to corrosive conditions involving sulphurous and hydrofluoric acids. EF (13) 5

Corrosion of Ferrous Metals in Acid Soils. I. A. DENISON & R. B. HOBBS. *Bureau of Standards Journal of Research*, Vol. 13, July 1934, pages 125-150. Corrosion of ferrous metals in acid soils is influenced largely by the acidity of the soil. A definite correlation was obtained between the average rates of pitting of ferrous specimens exposed to acid soils for 8-10 years and the total acidity of the soil. A similar correlation was also obtained between the total acidity of soils and losses of weight of steel specimens in laboratory tests. The effect of acidity in inducing corrosion is attributed to its action in preventing the formation of protective layers of ferrous and ferric hydroxides. The pitting factor defined as the ratio of the maximum depth of pits to the average depth of penetration is shown to be roughly proportional to the ratio of the uncorroded to corroded areas on a metal surface. Measurements of several physical properties of soils which determined their permeability were correlated with the pitting factor indicating that the more permeable the soil, exclusive of sands, the greater is tendency for corrosion to take the form of pitting, other conditions being the same. Certain soils may be so impermeable that the rate of pitting in them is very low. WAT (13) 6

The Effects of Superposing Cyclic Stressing upon Chemical Corrosion. A. J. GOULD. *Engineering*, Vol. 138, July 27, 1934, pages 79-81. Describes in detail tests carried out on 0.018-in. steel wire of the following composition: C 0.058%, Mn 0.362%, S 0.041%, P 0.014%, Si trace. Six spray solutions applied daily consisted of M/2 KCl containing nil, M/1,000, M/100, M/30, M/10 or M/2 K_2CrO_4, respectively. Damage by this spraying was measured by weight loss, by decrease of electrical conductance, by loss of tensile strength and by loss of fatigue-corrosion strength. It was found that the actual attack causing weakening and failure was not the visible external corrosion, but sharply-ended narrow fissures running into the metal, and probably following pre-existing slip bands. Weight-loss and electrical-resistance methods failed to distinguish stressed and unstressed conditions. Methods based on the shortening of the subsequent alternating stress life indicate a greater damage under conditions of stressed corrosion. Effect of cyclic stresses in making the metal locally more attackable can be attributed either to continued rupture of a film or to continued unblocking of pores from secondary corrosion product or to distortion of the space lattice. Graphs and tables show results of these tests. LFM (13) 7

Protection Layer Polarization in the Case of Chemical Passivity (Über die Deckschichtenpolarisation bei chemischer Passivität). W. J. MÜLLER. *Die Naturwissenschaften*, Vol. 22, July 7, 1934, page 479. The experimentally determined potentials occurring when Pb, Cr, Fe, Ni and Co go into solution at a higher valency are compared with the theoretically derived values and found to agree within about 1 volt thus supporting the author's electron theory of chemical passivity. EF (13) 8

Behavior of Rustless Steel against Corrosion (Ueber das Verhalten rostfreien Stahls gegen Korrosion). W. PALMAER. *Korrosion und Metallschutz*, Vol. 10, Aug. 1934, pages 181-190. Theories of rusting and methods of accurately determining it are reviewed. The corrosion resistance of ordinary rustless Cr steel can be explained by the theory of local elements; such steel dissolves in HCl just as quickly as ordinary, Cr-free steel with same low C content, but Cr has a certain preference in the dissolution. The "periodic phenomena" which have been observed during dissolution are to be ascribed to an alternating dissolving of Cr and Fe which explains the variable amount of gas developed per unit time. Cr is, therefore, primarily oxidized in humid air, but as it is easily passivated and the oxide layer formed on the surface is very dense, further attack is inhibited. The same holds true for steel with addition of Cu; here Cu takes the place of Cr and forms a protective layer. Ha (13) 9

Cylinder Liner Wear in High-speed Diesel Engines. H. J. NICHOLSON. *Gas & Oil Power*, Vol. 29, Feb. 1934, pages 47-48. Paper before the Institute of Marine Engineers, 1932, deals largely with the importance of lubrication and air and oil filtering devices. The question is left open as to how far corrosion is responsible for cylinder wear. Microscopic examination of Diesel engine cylinder walls often shows a surface etched as by acid. WH (13) 10

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Electrical Equipment Manufacturer—Durimet Pickling racks, pins, bars, castings

Food Co.—Durimet Rotary Valves

Glass Co.—Alcumite bolts, nuts, washers, castings

Hardware Plater—Durimet pumps, valves, castings

Insecticide Co.—Durimet pumps, valves, castings

Jewelry Manufacturer—Special Durimet castings

Kraft Paper Co.—KA2S valve assemblies, washers, castings

Lotion Maker—KA2S fittings, special castings

Milk Machinery Manufacturer—KA2S valve parts, special castings

Nitric Acid Maker—Durimet pumps, valves, parts

Oil Refinery—Durimet steam jets, special castings

Pulp & Paper Mill—Digester strainer, pumps, valves, fittings

Quarry Machinery Manufacturer—KA2S fittings, Alcumite rod, Durimet castings

Rayon Plant—Durimet pumps, valves, pipe fittings

Soap Maker—Durimet jets, bolts, valves, castings

Textile Co.—Durimet pumps, rods, nuts, castings

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Investigations on the Influence of High-Frequency Current on Corrosion of Iron (Untersuchungen über den Einfluss von Hochfrequenzstrom auf die Korrosion von Eisen). E. MAASS & V. DUFFEK. *Korrosion und Metallschutz,* Vol. 10, Apr. 1934, pages 85-88. Very specific tests proved that high-frequency currents of radio circuits accelerate corrosion in sewer pipes, gas lines, etc. The cause of the increased corrosion must be seen in a partial rectification of the high-frequency current which is brought about by a detector effect between metal and the corrosion products adhering to the metal. Ha (13)

Contribution to the Study of the Chemical Resistance of Various Special Steels. A. M. PORTEVIN, E. PRETET & H. JOLIVET. *Iron & Steel Institute, Advance Copy* No. 9. Sept. 1934. 53 pages. *Iron & Coal Trades Review,* Vol. 129, Sept. 14, 1934, pages 373-374 (abstract). The first part contains a discussion of the mechanism of oxidation of metals at elevated temperatures, a discussion of methods for determining rates of oxidation, and experimental data on rates of oxidation of different Fe alloys. The alloys studied were low-C steels containing various amounts of Al, Si, or Cr. Rate of oxidation was determined by holding specimens at the desired temperature in purified O_2 and determining change in pressure of O_2. Oxidation as a function of time followed the parabolic law and could be explained by diffusion except where rate of oxidation was so small that curve was uncertain. When the amount of Al, Si, or Cr was sufficiently great, depending on the temperature, oxidation became almost negligible. Oxide layers produced were examined microscopically and the observations carefully described. The examinations did not help explain the resistance to oxidation of the highly alloyed iron, but it is suggested that a better understanding of the oxides produced would help in the development of alloys resistant to oxidation. The second part of the article contains data on the resistance of Fe-Ni-W alloys of the austenitic type to attack by HCl solutions of different strengths. It is shown that both heat treatment and surface condition are important in influencing the solubility in acid. The Fe-Ni-W diagram proposed by Winkler and Vogel is described and results of microscopic and dilatometric studies of alloys from a portion of the system are given. The Curie points for a series of alloys were also located. 25 references. Ha + JLG (13)

Corrosion III (Korrosion III). Third Corrosion Congress Verein deutscher Ingenieure, Verein deutscher Eisenhüttenleute, Deutsche Gesellschaft für Metallkunde and Verein deutscher Chemiker, Nov. 14, 1933. VDI Verlag, Berlin, 1934, Paper 6x8¼ inches, 79 pages. Price 5 RM.

A collection of the following eight papers, previously abstracted, presented at this congress. **Corrosion and Fatigue (Korrosion und Ermüdung).** K. LAUTE. See *Metals & Alloys,* Vol. 5, May, 1934, page 210-R10. **Intercrystalline Corrosion in Various Metals and Alloys Especially in Stainless Steels (Interkristalline Korrosion in verschiedenen Metallen und Legierungen, insbesondere in rostfreien Stählen).** A. FRY & P. SCHAFMEISTER. See *Metals & Alloys,* Vol. 5, May, 1934, page 229-L3. **Corrosion Properties of Bronzes (Über die Korrosionsfestigkeit der Bronzen).** O. DAHL. See *Metals & Alloys,* Vol. 5, July, 1934, pages 366-R9. **Correlation Between Dissolving Speed, Solvent and Lattice Forces in Copper Single Crystals (Über den Zusammenhang zwischen Lösungsgeschwindigkeit, Lösungsmittel und Gitterkräften bei Kupfereinkristallen).** R. GLAUNER. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 455-R19. **The Varying Behavior of Protective Zinc Plates in the Boilers of the German Railway Steam Ferries (Das wechselnde Verhalten von Zinkschutzplatten in den Kesseln der Reichsbahnfährschiffe).** R. KÜHNEL. See *Metals & Alloys,* Vol. 5, June, 1934, page 291-L6. **Effect of Heat Treatment on the Corrosion Stability of Condenser Tubes (Der Einfluss der Glühbehandiung auf die Korrosionbeständigkeit von Kondensatorrohren).** E. SCHUMANN. See *Metals & Alloys,* Vol. 5, June 1934, page 292-L3. **Progress in Painting Aluminum and Aluminum Alloys (Fortschritte im Anstrich von Aluminium und Aluminiumlegierungen).** ECKERT. See *Metals & Alloys,* Vol. 5 July, 1934, page 343-R4. **New Tests with Duralplat (Neuere Versuche mit Duralplat).** K. L. MEISSNER. See *Metals & Alloys,* Vol. 5 June, 1934, page 292-R7. VVK (13)—B—

The Cause and Prevention of Corrosion in Steam and Hot Water Systems. (Die Entstehung und Verhütung der Korrosion an Heizungs—und Warmwasserbereitungsanlagen). O. KRÖHNKE & D. L. STIEGLER. Industrie-Verlag Carl Haenchen, Halle a. d. Saale, 1933. Cloth, 4½ x 6½ inches, 152 pages. Price 5 RM.

1 This little book was prepared under the auspices of the Reichsverband des Zentralheizungs- und Lüftungsfaches E.V. to fulfill the demand for a work summarizing information on the fundamental principles of corrosion and its prevention in steam and hot water systems. Fundamental theory is adequately and readably covered, particular emphasis being placed on the effect on corrosion of dissimilar metals in contact in the presence of an electrolyte and on the action of dissolved gases. The particular factors affecting corrosion in boiler systems are then taken up such as the influence of the composition of the feed-water, change in solubility of dissolved gases by increaese in temperature, effect of heating on the alkaline earth carbonates, potential difference between pipes carrying hot and cold water when immersed in water, and corrosion in contact with an electrolyte when the electrolyte is not changed. Direct chemical attack can occur from corrosive 2 constituents in the flue gas such as oxygen, sulphur and carbon dioxide. A small difference in the composition of the material is not important as only the surface condition and mechanical treatment of the material influence corrosion up to a certain degree. Hot water heaters of commercially pure iron have corroded as rapidly as those of the usual steel construction. The forms of corrosion such as uniform rusting, pitting and graphitization are discussed and illustrated. Excellent results were obtained with 18-8 Cr-Ni steel and with a 11.5-1 Cr-Ni steel. Copper was found to be attacked by some waters. Methods of removing dissolved gases by mechanical and chemical methods and protection of the material by non-metallic and metallic coatings are reviewed. The book is an excellent review of German work on boiler corrosion, with the greater space devoted to principles of corrosion as affecting the subject, but does not cover the developments in this country. 3 V. V. Kendall (13)—B—

Corrosion of Iron Walls by Cyanization Mixtures (Die Korrosion von Eisenwandungen durch Zyanisierungsgemische). BRUNO WAESER. *Werkstoffe und Korrosion,* Vol. 9, June 25, 1934, pages 21-22. Alkali carbonate-C mixtures at high temperatures absorb N with formation of cyanide; presence of Fe acts as catalyzer and accelerates the process. Iron and steel in contact with alkaline substances at high temperatures lose their C so that quick corrosion follows. Experiments are described which demonstrate this action clearly on etchings of different alloy steels. Ha (13)

Corrosion of Light and Extra-Light Alloys (La Corrosion des Alliages Legers et Ultra-Legers). P. BASTIEN. *Chimie et Industrie,* Vol. 32, July 1934, pages 10-20; *La Technique Moderne,* Aug. 1, 1934, page 538. Very light alloys, 4 i.e. those of Al and Mg, are being used more and more. They are, however, very susceptible to atmospheric agents. The author reviews the study of the reactions of these corrosive agents on these metals, the methods of determining corrosion and the methods of measuring the amount of corrosion. He also reviews the results obtained from tests on light alloys resistant to corrosion. FR + MAB (13)

Increase of Dissolution Velocity of Iron by Oxidizing and Reducing Substances (Die Erhöhung der Auflösungsgeschwindigkeit des Eisens durch oxydierende und reduzierende Substanzen). F. TOEDT. *Zeitschrift für Elektrochemie,* Vol. 40, July 1934, pages 536-541. A number of solutions was tried among which potassium permanganate and potassium bichromate showed particular tendency to passivate Fe. Theoretical questions as to cause of passivation and relation to 5 structure of the metal and the dissolving liquid are discussed. Ha (13)

Studies on the Corrosion Problem of Condenser Tubes. TOMOJIRÔ TANABE & GORÔ KOISO. *Journal Society of Mechanical Engineers,* Vol. 37, Aug. 1934, pages 506-516. In Japanese. Paper read before the Meeting of the 51st Western Division of the Society of Mechanical Engineers, Oct. 19, 1933. Discussion of results of corrosion tests on condenser tubes of different materials of which chemical composition and mechanical properties are given. The tests were carried out in a specially constructed condenser. "Albrac," 76-80% Cu, 2.0% Al, 0.3% Si, remainder Zn, and its group resisted corrosion and erosion best, followed by Cu-Ni alloys (30% Ni). The jet test was carried out on Admiralty metal, Si brass, P bronze, and the Cu-Zn alloy system. Kz (13)

6 **Effect of Chemical Treatment of Well Fluid on Tubing Corrosion.** WALTER F. ROGERS. *Oil & Gas Journal,* Vol. 33, May 24, 1934, pages 14-42. See *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 421. VVK (13)

An Approved Test for the Determination of Reactivity of Aluminum and Aluminum Alloys (Eine bewährte Probe zur Ermittlung der Reaktionsfähigkeit von Aluminium und Aluminiumlegierungen). H. ROEHRIG. *Korrosion und Metallschutz,* Vol. 10, Feb. 1934, pages 38-39. A method to test the resistance against attack by chemicals which gives accurate comparative results not only for samples of different chemical composition but also of same composition but of different thermal treatment, consists in determining the loss in weight of samples which are, after a preliminary treatment with a 30% NaOH solution and concentrated HNO_3, exposed to attack of a mixture of 4 parts H_2O, 4 parts concentrated 7 HNO_3 and 1 part concentrated HCl at 20°C. A few examples illustrate the procedure which gives better and quicker results than the test with HCl according to Mylius. Ha (13)

Organic Substances and the Acid Corrosion of Iron (Organische Substanzen und die Säurekorrosion des Eisens). H. PIRAK & W. WENZEL. *Korrosion und Metallschutz,* Vol. 10, Feb. 1934, pages 29-38. The inhibitory action of certain organic substances in retarding the dissolution of metals in acid was investigated. There exists a connection between chemical constitution of an organic substance and its capacity to retard or prevent dissolution (for instance in pickling), and this action depends on the presence of certain atom groups and on the molecular size and molecular weight. Recent literature and patents of substances exerting 8 inhibitory effect are cited. Aldehydes, nitriles, amines, heterocyclic compounds with N, S and N and S containing compounds form the principal groups. The various theories are discussed. 22 references. Ha (13)

Effect of Alternating Currents on the Corrosion of Metals in Aqueous Solutions (Ueber den Einfluss von Wechselströmen auf die Korrosion der Metalle in wässerigen Lösungen). M. SMIALOWSKI. *Korrosion und Metallschutz,* Vol. 10, July 1934, pages 166-168. The effect of low frequency (50 cycles) and high-frequency (6×10^7 cycles) was investigated. The action of an alternating current on an electrolytic process must be ascribed primarily to the mechanical vibration connected with it which facilitates the contact of O with the metal in a solution and thus increases corrosion. The effect is the greater the lower the frequency; 9 consequently, earth (vagabond) currents near rails are more dangerous to sewer or gas pipes than radio currents. The effect of the latter shows itself only at current densities in excess of 5 milliamp./mm.^{2} Ha (13)

Comparative Measurements of Corrosion in Refrigeration Brines (Vergleichende Messungen über Korrosion in Kühlsolen). J. SCHWAIBOLD & J. WIESENT. *Zeitschrift für die gesamte Kälteindustrie,* Vol. 41, Mar. 1934, pages 52-53. The disagreeing results of corrosion tests with freezing solutions are ascribed to incomparable testing conditions. Imitation of actual service conditions is urged. The experimenters set out to determine whether so-called "Kunstsolen" (special commercial brines) are actually less corrosive than ordinary plain solutions of technical salts. This question has been answered in the affirmative with reference to Reinhartin and Thermolyt, brines most widely used in Germany. At —20°C., 10 the former ceases to attack Fe. A corrosion rate of 4.8 : 7.4 : 9 : 15 was established for Reinhartin, $MgCl_2$, Thermolyt, and $CaCl_2$ respectively with reference to Fe in contact with Pb and at room temperature. This ratio changes at —20°C. as follows: 1.2 : 5 : 4 : 6. The same favorable behavior of the special less corrosive brines has been confirmed in tests on Cu, brass and Zn (galvanized Fe). EF (13)

APPLICATIONS OF METALS & ALLOYS (14)

Dental Metals and Their Manipulation. E. W. SKINNER. *Metal Progress*, Vol. 26, Aug. 1934, pages 41-44, 58. Describes the properties desired in alloys for dental castings and the technique of making such castings. Silver alloys for amalgam fillings and use of stainless steels for dental work are discussed. WLC (14)

Wear of Piston Rings and Liners Influenced by Design of Rings. W. G. G. GODRON. *Journal Institute of Fuel*, Vol. 7, Aug. 1934, pages 309-315. Presented before City & Guilds Engineering Society, May 29, 1934. Use of proper grooving aims to counterbalance high gas pressures, minimize frictional resistance and destructive wear, distribute ring loading more equally to all rings, prolong life of rings and liners, reduce ring temperatures and minimize the formation of deposits. AHE (14)

Gage Blanks. *United States Bureau of Standards, Commercial Standard* CS8-33; *American Standards Association*, ASA B47-1933, Dec. 22, 1933, 54 pages. The standard covers designs for plain and thread plug gage blanks to 12.010 in. maximum gaging diameter, plain and thread ring gage blanks to 12.260 in. maximum gaging diameter, adjustable snap gages to 12 in., adjustable length gages to any desired length, and twin ring gages or combination ring and snap gages for work up to 1.135 in. diameter. AHE (14)

Marking of Gold Filled and Rolled Gold Plate Articles Other Than Watchcases. *United States Bureau of Standards, Commercial Standard* CS 47-34; *American Standards Association*, ASA Z31-1933, Jan. 27, 1934, 9 pages. AHE (14)

Tentative Specifications for Electric-Fusion-Welded Steel Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A139-32T; *American Standards Association*, A. S. A. No.: B36.9-1934, 6 pages. Includes standards for chemical composition, physical properties, dimensions, etc. AHE (14)

Tentative Specifications for Riveted Steel and Wrought-Iron Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A138-32T; *American Standards Association*, A.S.A. No.: B36.8-1934, 3 pages. Includes standards for materials, manufacture, hydrostatic tests, etc. AHE (14)

Standard Specifications for Welded and Seamless Steel Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A53-33; *American Standards Association*, A.S.A. No.: B36.1-1934, 6 pages. Includes standards for chemical composition, physical properties, dimensions, etc. AHE (14)

Standard Specifications for Welded Wrought-Iron Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A72-33; *American Standards Association*, A.S.A. No.: B36.2-1934, 5 pages. Includes standards for chemical composition, physical properties, dimensions, etc. AHE (14)

Tentative Specifications for Lock-Bar Steel Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A137-32T; *American Standards Association*, A.S.A. No.: B36.7-1934, 5 pages. Includes standards for chemical composition, physical properties, manufacture, dimensions, etc. AHE (14)

Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service. *American Society for Testing Materials*, A.S.T.M. Designation: A106-33T; *American Standards Association*, A.S.A. No.: B36.3-1934, 11 pages. Includes standards for chemical composition, physical properties, dimensions, etc., and supplementary requirements for seamless pipe for use in Central stations at pressures of 400 lb./in.² or over, and temperatures of 750° F. AHE (14)

Tentative Specifications for Forge-Welded Steel Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A136-32T; *American Standards Association*, A.S.A. No.: B36.6-1934, 5 pages. Includes standards for chemical composition, physical properties, dimensions, etc. AHE (14)

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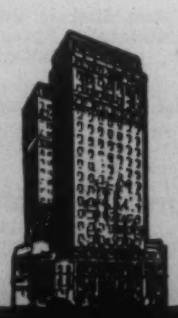

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Non-Ferrous (14a)

G. L. CRAIG, SECTION EDITOR

Practical Experience with Aluminum as High Tension Cable Material (Betriebserfahrung mit Aluminium in Hochspannungsleitungen). JOHN AUGUSTIN. *Elektrizitätswirtschaft*, Vol. 33, June 15, 1934, pages 213-218. The author discusses critically and in great detail the experiences with pure Al and steel/Al overhead transmission lines during the past 16 years in Germany. Particular attention is paid to the failures. Supported by 20 illustrations most of which refer to suspension and joining devices, on which practically all the blame is placed, the author arrives at the conclusion that the sources of trouble have been determined and eliminated so that safe operation of light metal alloy cables is fully guaranteed. It is pointed out that no difficulties were encountered with the cable material steel/Al itself during a 12 years' service. Complete failure of a pure Al cable due to severe atmospheric corrosion in an industrial center necessitated the installment of new cables after 10 years operation. Cu cables under the same conditions failed after 12 years. WH (14a)

1

Progress in Aluminium Tanks for Transportation of Liquids (Les progrès des camions-citernes en aluminium). JEAN BALLY. *Revue de l'Aluminium et de ses applications*, No. 59, Jan.-Feb. 1934, pages 2333-2338. Description of several trucks and calculation of the economy brought about by the use of Al. AH (14a)

New Applications for Tin. *Tin*, July 1934, page 9. Leaflet No. 1 of the Technical Publications of the International Tin Research and Development Council describes a new type of accumulator; a Sn wire takes the place of the negative Pb plate in the ordinary storage battery. As no H is evolved in the cell it can be sealed so that the cell can be used in any position. Special advantage is its greater lightness. Ha (14a)

Photography on Aluminum (Photographie auf Aluminium). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Aug. 5, 1934, page 493. In the Seo (Siemens Electro-Oxidation) photo method an inorganic colloid, Al_2O_3 is used as bearer of substances sensitive to light. The photo layer thus impregnated can be used for manifold photographic purposes according to composition and light sensitivity. The Seo photos are distinguished by high durability and high resistivity to heat. The field of application of the new method is outlined. GN (14a)

2

Metallurgy Perfects Strong-As-Steel Die-Castings. *Product Engineering*, Vol. 5, Sept. 1934, pages 336-337. A new die-casting Cu alloy "Brastil" (composition not given) is used for parts subject to high stresses and impact. If the hardness of the alloy is not sufficient steel inserts are incorporated. Ha (14a)

New Uses for Some of the Non-Ferrous Metal Alloys. *Machinery*, N. Y. Vol. 41, Oct. 1934, page 106. Die-castings of Al and Al alloys, Be-Cu, Basaloy (a non-shrinking, non-expanding metal with a melting point of 225° F.) are illustrated. Ha (14a)

Improved Methods and Alloys in the Die-Casting Industry. *Machinery*, N. Y., Vol. 41, Oct. 1934, pages 107-108. Examples of small parts of alloys with Al or Cu base are described. Ha (14a)

Aluminium Floor for an Old Bridge. *Engineer*, Vol. 158, July 27, 1934, pages 93-95. Illustrated article discussing repair of the Smithfield St. bridge at Pittsburgh, Pa., by replacing the timber flooring, a fire hazard, with a new heat-treated aluminum alloy. The properties of the alloy used are: tensile strength 58,000 lbs./in.², yield point 35,000 lbs./in.² and elongation in 2 in., 20%. See also editorial in *Engineer*, Vol. 158, July 27, 1934, page 91. LFM (14a)

3

Copper Roofing in the United States (Les Toitures en Cuivre aux États-Unis). *Cuivre et Laiton*, Vol. 7, July 15, 1934, pages 295-299. Methods, practice, material used in copper roofing and examples of some important buildings are discussed; methods of formation of artificial patina are described. Ha (14a)

Tests on White Metals for Socketing Winding Ropes. JOHN WILSON. *Colliery Guardian*, Vol. 147, July 7, 1933, pages 4-5. See *Metals & Alloys*, Vol. 5, July 1934, page MA 368. VVK (14a)

Interior Decoration and Household Art: Monel Metal (Ornementation Intérieure et art ménager: le métal monel). J. PICARD. *Revue du Nickel*, Vol. 5, Jan. 1934, pages 36-51. A fully illustrated description of the use of Monel metal for the above mentioned purpose. AH (14a)

4

Operating Experiences with Aldrey Transmission Lines (Einige Betriebserfahrungen mit Aldreyleitungen). M. THOMAS. *Elektrotechnische Zeitschrift*, Vol. 55, July 26, 1934, page 748. Aldrey, an Al alloy of 98.7% Al, 0.3% Fe and 1% Si and Mn, is used extensively for electric transmission lines on the continent; up to 1933, 5000 tons had been used. Its advantages over Cu and steel-Al are low weight, great strength and therefore less sag, so that danger of 2 lines hitting each other under swinging is reduced. Reduction of tensile stress in this material with increasing temperature is less than in Cu and Al. Ha (14a)

Aluminum as Heat Insulation Material (Aluminum als warmte-isoleermiddel). A. VOSMAER. *Polytechnisch Weekblad*, Vol. 29, Mar. 22, 1934, page 185. Discusses "Alfol," an insulation made up of Al foil of 0.0003 in. thickness and based on the reflection power of 95% of incidenting heat radiation on the part of Al. The Al foils are placed 8 mm. apart. The weight of an Alfol insulation of 1 m.² is only 1 kg. WH (14a)

5

New Fields of Use for the Rare Earths (Neuere Verwendungsgebiete der seltenen Erden). KARL QUASEBARTH. *Chemiker-Zeitung*, Vol. 58, May 5, 1934, pages 365-367. While the use of Ce in Welsbach gas mantels is decreasing, it is now added to C electrodes for arc lamps as CeF_3, and as $Ce(No_3)_3$ to Mg powder for flash lights. When used in medicine it must be very pure. Ce is used in glass both as decolorizing and coloring agent. .2% Ce compound will decolorize glass containing .01% FeO. Nd impurity in the Ce is helpful for this purpose. Pure Nd_2O_3 added to glass produces between a red and violet color, Pr between green and yellow. This color cannot be obtained by any other means. Pr is used in yellow eye glasses, such as sun glasses. Th is used as a catalyst, in medicine, and in alloys. CEM (14a)

High Quality Material in Motor Construction (Hochwertiger Werkstoff im Motorenbau). JOH. MEHRTENS. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, July 8, 1934, pages 285-296. Author discusses recent developments in this field. The high Si, Al casting alloys developed by K. Schmidt, Neckarsulm, are discussed. This alloy which has also been successfully applied for Diesel engine pistons is distinguished by an exceptionally low heat expansion coefficient, good heat conductivity, high hot tensile strength. Piston rings are successfully processed by centrifugal casting method. Use of Meehanite cast Fe for crank axles and shafts is mentioned. GN (14a)

6

White Metals for Architectural Purposes (Les métaux blancs dans l'architecture). M. P. LEPRINCE-RINGUET. *Revue du Nickel*, Vol. 5, Jan. 1934, pages 2-5. An essay describing the uses of 18-8 Cr-Ni steels and Monel metal for architectural purposes. AH (14a)

The Beneficial Use of Tin Compounds in Lubricants. E. W. J. MARDLES. *Technical Publications of the International Tin Research & Development Council*, Series C, No. 2, Aug. 1934, 3 pages. Since engine lubrication failure is thought to be partly due to oxidation of oil, anti-oxidants were sought. Metals and metallic compounds were tried at temperatures from 120 to 225° C. Cu, Fe, Ag, V, Mn accelerated deterioration, Au, Hg, Cr, Ce, Bi, Sb were without effect but Sn or its oil-soluble organic compounds such as tin oleate or tin tetraphenyl decreased the rate of oxidation. It is suggested that a colloidal dispersion of tin dust might be useful in a lubricant for a journal bearing. HWG (14a)

7

Improvements in the Design of Pistons (Neuerungen im Kolbenbau). E. MAHLE. *Automobiltechnische Zeitschrift*, Vol. 37, June 25, 1934, pages 316-324. Recent developments in the design of pistons. Alloys of Al-Cu are used extensively because of their good heat conductivity and strength, and of Al-Si because of their excellent wear resistance and low heat expansion. Alloy EC 124 is a eutectic alloy of 12-13% Si to which Ni, Cu and Mg is added in order to obtain the required strength at high temperatures, wear resistance and elongation. An equilibrium diagram for Al-Si alloys is given. Different constructions of pistons and parts of cylinders are described. Ha (14a)

Lithium Occurrences (Lithiumvorkommen der Erde). F. HERMANN. *Die Metallbörse*, Vol. 24, Apr. 28, 1934, page 535, May 5, 1934, page 567. The natural occurrences of Li are pointed out and its commercial utilization is discussed. It is claimed that a few hundredths of a % of Li harden Al alloys remarkably. Li is utilized in German bearing metals ("Bahnmetall"). EF (14a)

Magnesium for Light-Weight Jigs. W. G. HARVEY. *American Machinist*, Vol. 78, Oct. 10, 1934, page 703. Examples for jigs and templates of Mg alloys are to illustrate that easier handling often compensates for higher initial costs in the use of light-weight material. Ha (14a)

Minimizing Bearing Troubles with Self-Lubricating Bronze Bushings. HERB. CHASE. *Machinery*, N. Y., Vol. 41, Sept. 1934, pages 9-12. A composite bushing of 90% Cu and 10% Sn is pressed from the powdered materials under a pressure of 20 tons/in.². It is porous and absorbs oil and graphite. Construction details and operating data are given. Ha (14a)

Manganese (Le Manganèse). M. DÉRIBÉRE. *Science et Industrie, (Métaux et Machines)*, Vol. 18, June 1934, pages 163-167. Reviews mineral forms in which Mn is found and where it occurs: Russia, India, Africa, Brazil, Chile, North America, France, etc., deals with Mn industry, discusses metallurgy of Mn: Mn carbide, Mn silicide, Mn Steels, Al-Mn, Mg-Mn, Ni-Mn and Cu-Mn alloys; and reviews uses of Mn in alloys: Mn as deoxiding addition, Mn steels, Mn bronzes, light alloys, chemical applications. FR (14a)

8

Aluminium and the Equipment of the Chemical Industry (IL'Aluminium et le matériel de l'industrie chimique). E. DELAROZIÈRE. *Revue de l'Aluminium et de ses applications*, No. 57, Sept.-Oct. 1933, pages 2219-2227. An essay on the use of Al in the chemical industry. AH (14a)

Stainless Steels for Architecture and Decoration (L'acier inoxydable en architecture et en décoration). A. BOBINET. *Revue du Nickel*, Vol. 5, Jan. 1934, pages 6-15. A description of the importance of 18-8 Cr-Ni steels for the above mentioned purpose. AH (14a)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

Most Important Reinforcements with High Yield Points for Reinforced Concrete Members with Particular Reference to the Benzinger Screen (Über die wichtigsten Bewehrungen mit hoher Streckgrenze für Eisenbetonbauteile unter besonderer Berücksichtigung des Benzinger Geflechts). A. KLEINLOGEL. *Beton & Eisen*, Vol. 33, Apr. 5, 1934, pages 97-104. Paper before the Deutsche Gesellschaft für Bauwesen discusses critically the various ferrous materials utilized in reinforced concrete with particular reference to the significance of their yield point. The speaker differentiates between high-grade steels with (a) natural yield points and (b) artificially raised yield points. The discussion comprises the following materials of both groups: (1) standard German structural steel, Steel St 52, (2) first quality open hearth steels in the first group, (3) cold rolled St 52, (4) Isteg iron and (5) cold drawn wire in the second group. The latest developments in the utilization of high-grade steels and in particular of steel screens with the object of raising the yield point of reinforced concrete members are summarized and test data presented. EF (14b)

Chevrolet's Knee-Action. JOHN M. BONBRIGHT. *Heat Treating & Forging*, Vol. 20, Mar. 1934, pages 117-120; *Iron Age*, Vol. 133, Mar. 1, 1934, pages 28B-28F. Describes the design and manufacture of the units. Housing is made by butt welding 2 low-C hot-rolled steel stampings, 5/32" thick. Steel for coil springs contains 0.55-0.60% C, 0.80% Mn, 0.040% max. P, 0.050% max. S, 1.80-2.20% Si. Tensile strength is 190,000 lbs./in.², elastic limit, 175,000-190,000 lbs./in.² Springs are formed in a special coiling machine from a 93 1/2" rod with a 11/16" diam., heated in a pusher-type furnace to 1600° F. Coiled springs are heated to 1600° F., quenched in oil, drawn at 950° C., and H_2O quenched. King-pin support yoke and steering-knuckle are made of Cr-Ni steel. The flanges of these forgings are produced by unusually difficult extruding operations. These are joined to other parts by welding. Bearing holes for the needle-roller type bearings used in the assembly are roller burnished. Parts are subjected to various tests during fabrication. MS + VSP (14b)

9

Increasing the Life of Haulage Ropes. *Engineering Progress*, Vol. 15, June 1934, pages 116-119. Premature weakening of steel haulage ropes is due to additional tensile and bending stresses caused by jerking and whipping the rope when loading the tubs, suddenly starting and braking, etc. The danger is eliminated by a special shock absorber between cage and rope. Operating results show several times the usual life. Ha (14b)

Tough-Hard, Shock Resistant Gearing. N. E. WOLDMAN. *American Machinist*, Vol. 78, Sept. 26, 1934, pages 661-664. Heat-treated gears are classified as (1) case-hardened gearing, where carburized low C plain and alloy steels are used, and (2) fully quenched medium C plain and alloy steels which are employed where heavy loads, high stresses, shock and impact have to be endured with rolling and sliding wear, as in railway, steel mill, and mine locomotive gearing. Heat treatment, structural features and physical properties of different steels are described. Ha (14b)

10

Steels in Marine Engineering Service. T. H. BURNHAM. *Steam Engineer*, Vol. 3, Aug. 1934, pages 491-492. Abstract of paper read before the Institute of Marine Engineers. See *Metals & Alloys*, Vol. 5, June 1934, page MA 299. AHE (14b)

High Grade Steel in Reinforced Concrete Structural Work (Hochwertiger Stahl im Eisenbetonbau). FRITZ VON EMPERGER. *Beton & Eisen*, Vol. 32, Nov. 20, 1933, pages 341-352. See *Metals & Alloys*, Vol. 5, July 1934, page MA 371. EF (14b)

The Use of Nickel Alloy Steels in Japan. JAMES A. RABBITT & SABURO WATANABE. *Far Eastern Review*, Vol. 30, Apr. 1934, pages 176-180, May 1934, pages 209-215. The paper accompanied by 37 illustrations and diagrams and 7 tables summarizes in the first part the commercial utilization of Ni in alloy steel castings, alloy steel forgings, steel plate and other special Ni steels in Japan. Among the special attributes of Ni in steels, strength combined with toughness, corrosion resistance, economy in case-hardening, and heat resistance are stressed in special chapters. Experimental data are tabulated and graphically presented. WH (14b)

Designing and Casting (Konstruieren und Giessen). 1. Cast Iron as Material (Gusseisen als Werkstoff), SIPP. 2. Design of Castings (Ueber Konstruktion von Gussstücken). KÜSTER. 3. Design of Steel Castings (Ueber die Konstruktion von Stahlgussstücken). RESOW. *Die Giesserei*, Vol. 21, Aug. 31, 1934, pages 361-369. Report on a symposium of the Verein deutscher Eisenhüttenleute. Historical data, composition of old Fe findings going back 2000 years, merits of cast Fe for machine parts and structures in spite of competition of modern development of other materials, necessity of cooperation of designer and foundryman, constructive details and molding technique to obtain good castings, are discussed. Ha (14b)

Cast Iron, the Dean of Ferrous Metals. J. M. LESSELLS. *Product Engineering*, Vol. 5, Oct. 1934, pages 375-376. Factors to be considered in the design of parts of cast Fe and formulas used are surveyed generally. Ha (14b)

Yield Point of Iron and Steel as Measure for Determining the Permissible Stresses in Reinforced Concrete Constructions (Die Streckgrenze von Eisen und Stahl als Massstab für die Bemessung der zulässigen Spannungen im Eisenbetonbau). A. KLEINLOGEL. *Beton & Eisen*, Vol. 33, Jan. 20, 1934, pages 33-35. The author differentiates between structural steel having a "natural" and "artificial" high yield point. The former is due to favorable alloying, while the latter is secured by cold work. Kleinlogel objects that cold worked structural steels are liable to lose part of their strength under adverse service conditions (for instance fire), that they are more brittle above the yield point and that, nevertheless, they are given preferential treatment in the official German specifications covering the maximum permissible load (2400-26000 kg./cm.² allowed recently) while for the high-grade structural steel St. 52 a maximum stress of only 1500 kg./cm.² is permitted. The author considers alloy steels with a natural high yield point as superior to cold worked structural steels in reinforced concrete work and demands that the former at least should not be handicapped by unjustifiable restrictions. EF (14b)

Development of Materials for Poppet Valves. C. C. HODGSON. *Heat Treating & Forging*, Vol. 20, Apr. 1934, pages 170-175. See *Metals & Alloys*, Vol. 5, July 1934, page MA 371. MS (14b)

The Manufacture and Inspection of Taps. L. G. J. HENSHAW & A. DOWNIE. *Inspection*, Vol. 5, Apr. 1934, pages 2-23. Includes discussion. Paper read before the Institution of Engineering Inspection, Dec. 14, 1933. Principal factors which have to be taken into consideration are hardness, torsion and malleability, for which purpose the following analysis has been found most satisfactory: 1.15-1.25% C, 0.10-0.20% Si, 0.20-0.35% Mn, 0.03% S max. After the discussion of the manufacturing process, heat treatment and finishing are dealt with. Experience has proved that best results are obtained by the use of an electrical furnace fitted with magnetic control. The charge is heated to 760° C. before quenching. The correct moment to quench is a matter of temperature and rate of heating. The critical point for quenching is the moment when the C goes into solution and coincides with the point when the non-magnetic condition is reached. This is indicated by means of the magnetic control. The tempering range is between 200°-220° C. In conclusion inspection and instruments used for inspection are dealt with. Kz (14b)

On the Manufacturing Status of Springs for Machinery. SÔZO HATTORI. *Journal of the Society of Mechanical Engineers*, Vol. 37, Mar. 1934, pages 131-133. (In Japanese.) Paper read before the 241st Meeting of the Society of Mechanical Engineers, Oct. 11, 1933. Brief discussion of the difference in the manufacturing processes according to the application of rolled steel or drawn wire for coiled springs. Analyses of spring steels (C, Si-Mn, Si-Cr, Cr-V) are tabulated. C steel containing 0.75-1.10% C is used for the majority of springs at present. Formulae for the calculation of coiled springs, modified for concurrence with actual test results, are discussed. Kz (14b)

Old and New Problems in Reinforced Concrete Research (Über einige Aufnaben der Eisenbetonforschung aus älterer und neuerer Zeit). OTTO GRAF. *Beton & Eisen*, Vol. 33, June 5, 1934, pages 165-173. Lecture before the 37th General Meeting of the Deutscher Beton Verein, Apr. 1934, critically discusses among other problems shrinkage stresses in steel reinforcements in concrete, permissible stresses, and the useful resistance of steel and round Fe bars vs. reinforced concrete under static and oscillating loads. EF (14b)

Long Span Bridges. RALPH FREEMAN. *Railway Engineer*, Vol. 55, Aug. 1934, pages 244-246. Special attention is paid to the improvements in quality of steel and construction of joints in the evolution of long span bridges. In the early part of this century mild steel with a yield stress of 15 tons/in.² (working stress of 7.5 tons/in².) was generally utilized. Si steel used for many American bridges is about 1/3 stronger than mild steel and low Cr steel now being made in Germany and England has a yield stress of about 23 tons per sq. in. and will sustain a working stress about 50% higher than mild steel. A span of 2500 ft. for heavy traffic is quite possible and a bridge of the arch or cantilever type would be cheaper than a suspension bridge up to 1500 ft. span. Due to the advancements in steel quality and modern construction methods the cost of a long span bridge is now less than a series of shorter spans supported on piers. WH (14b)

Steel Staterooms on Ships (Stahl-Fahrgastkammern an Bord von Schiffen). E. FOERSTER. *Werft, Reederei & Hafen*, Vol. 15, Apr. 1, 1934 pages 82-83. Experiments are under way in Germany to replace the wooden parts of state-rooms on ocean liners by steel. The favorable experiences in the U.S.A. with all-steel hotels are pointed out. German steel walls and doors, which incorporate a sound-proof glass wool filling, are heavier but offer a superior sound insulation and are fire-proof. So far sheets of 1.25 mm. thickness placed 25 mm. apart have been utilized but by proper design .87 mm. sheets at a distance of 18-20 mm. are feasible. Further lowering of assembling costs are predicted. WH (14b)

Cast Iron in Bridge Building (Gusseisen im Brückenbau). ERNST ELLMER. *Die Giesserei*, Vol. 21, Sept. 14, 1934, pages 398-399. Describes a cast iron-concrete bridge of 75.6 m. span. Ha (14b)

Solingen Steel Ware (Solinger Stahlwaren). *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 29, 1934, pages 458-460. Discusses at length the procedure in manufacturing cutlery ware, describing (1) forging, (2) heat treating, (3) grinding. GN (14b)

Use of Nickel and Nickel Alloys in Chemical Industry (Les emplois du nickel et de ses alliages dans les industries chimiques). *Génie Civil*, Vol. 104, May 1934, pages 432-433. Describes some of the commoner applications of Ni and its alloys to the problems of chemical industry. JDG (14b)

Revocon System. *Enamelist*, Vol. 11, July 1934, pages 9-11, 15. The revocon system is a new process (patents pending) of construction for buildings permitting use of porcelain enameled metal in sheet form on exterior and interior surfaces. Details of construction are described and illustrated. Ha (14b)

International Congress for Steel Development. *Engineer*, Vol. 157, June 29, 1934, pages 650-651; *Engineering*, Vol. 137, June 29, 1934, pages 726-727. Summary of papers presented before the Congress discussing recent advances made in the building of steel structures. LFM (14b)

Steel Reinforcing Spirals. *U. S. Bureau of Standards Simplified Practice Recommendation* R53-32, Dec. 15, 1932; *American Standards Association*, American Standard A38-1933, 11 pages. AHE (14b)

Alloy Steel Tubes (Le Tube en acier spécial). *Aciers Speciaux, Metaux et Alliages*, Vol. 9, Mar. 1934, pages 93-98. General discussion of the use of alloy steel tubes. GTM (14b)

Tentative Specifications for Electric-Fusion-Welded Steel Pipe (Sizes 30 in. and Over). *American Society for Testing Materials*, A. S. T. M. Designation: A134-32T; *American Standards Association*, A. S. A. No.: B36.4-1934, 3 pages. Includes standards for physical properties, dimensions, etc. AHE (14b)

Tentative Specifications for Electric-Resistance-Welded Steel Pipe. *American Society for Testing Materials*, A.S.T.M. Designation: A135-32T; *American Standards Association*, A.S.A. No.: B36.5-1934, 6 pages. Includes standards for chemical composition, physical properties, dimensions, etc. AHE (14b)

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Wood or Steel Casing? (Holz oder Stahlschalung?). ADOLF SCHULER. *Beton & Eisen*, Vol. 33, Mar. 5, 1934, pages 76-79. In concrete work, steel has recently become a competitor of wood as casing material. The question wood or steel is answered: both. Those cases are pointed out where a greater economy is assured by the adoption of steel. EF (14b)

The Stainless Steels in the Steel Ware Industry (Die nichtrostenden Stahle in der Stahlwaren-Industrie). PAUL SCHAFMEISTER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, July 29, 1934, page 464. The 2 principal types of stainless steel used by steel ware industry are the hardenable Cr steel (average composition: C: .45%, Cr: 14% Ni: .5%) as applied for cutlery and the tough, deep drawing Cr-Ni steel (C: .11%, 18% Cr 8% Ni) for forks, spoons, etc. Data are given on heat treatment, mechanical and corrosion properties of these steels. The causes and factors affecting the corrosion stability are outlined. Important factors which affect the corrosion stability are composition, microstructure, heat treatment and surface condition. The Cr content required for good corrosion properties must amount to at least 12%. If the C content is high, Cr content must be high, for the homogeneous structure (apparently martensite in the hardenable Cr steel and austenite in the tough Cr-Ni steel) possesses the highest corrosion stability. This homogenous structure is not attained, however, if the Cr and C contents are not balanced and the proper hardening temperature is not chosen. GN (14b)

Steel for the Finishing Industry. L. SANDERSON. *Synthetic & Applied Finishes*, Vol. 5, July 1934, pages 96-97. Heat treatment of steel in a H_2 atmosphere is found to improve the plating (Ni, Ni-Cr, Cr), but even in unplated steel the power of withstanding corrosion is raised by this means. The best form of plating is obtained by the use of a Co-Ni alloy which is electrolytically deposited. This gives a very white finish approximating to Ag. The rustless properties are claimed to approach those of austenitic stainless steel. Co-W steels are best suited for absolutely plane parallel mirrors, the mirror bases being coated with Cr, Co-Ni or Rh. The Rh mirror has a greater reflection power but is comparatively soft. Other recent developments discussed are bonding of sheets of different metals, heat treatment in a dilute atmosphere of Cl_2, asphalt coating of steel sheets, 18/8 with lower Cr and higher Ni contents is suitable for very deep stamping, is amply resistant to corrosion but cannot be obtained in the form of castings. Se instead of S renders austenitic steels machinable with comparative ease. Successful manufacture of rustless steel wire and wire rope as competitor for coated high-grade C steel, brass, P-bronze and monel metal products is pointed out. A coating of Pb on tubes, rods, wire of C and alloy steels to be cold drawn serves as a lubricant and greatly reduces the number of annealing and pickling operations. Al-Fe-Ni alloys are lighter, cheaper and more efficient than the present Co-Cr-W magnetic alloys. A 25/15 Cr-Ni steel was found to operate successfully at 800° C. in the making of cotton cloth. Ta carbides are replacing W carbides and Cr-W-Co (over 50% Co) alloys are introduced as cutting materials. EF (14b)

Wire Rope. C. D. MEALS. *Wire and Wire Products*, Vol. 9, July 1934, pages 205-212. After a brief historical sketch of development of wire rope which was made just 100 years ago for the first time, exhaustive data are given on various forms of ropes, tables and formulas for calculation of engineering problems, physical properties of material used and fittings for ropes. Ha (14b)

GENERAL (15)

RICHARD RIMBACH, SECTION EDITOR

Handbook of Chemistry and Physics. 19th Edition. Chas. D. Hodgman, Editor-in-Chief. Chemical Rubber Publishing Co., Cleveland, Ohio, 1934. Fabrikoid, 4½ x 6¾ inches, 1933 pages. Price $6.00. The 19th edition of this handbook has 115 pages more than the 18th edition. The handbook has now been divided into five sections, approximately equal in size. These sections are indicated by inserts of stiff colored paper on which is printed a summary of the contents of that particular section. This summary supplements the complete Table of Contents in the front of the book and the cross index in the back of the book. The five sections into which the handbook is divided are: 1. Mathematical Tables, 2. Properties and Physical Constants, 3. General Chemical Tables, 4. Heat and Hygrometry, Sound, Electricity and Light, and 5. Quantities and Units—Miscellaneous Tables. The most extensive of the new tables added to the nineteenth edition is the one on X-Ray Crystallographic Data. In this table is given the type of structure, the space group, the dimensions of the unit cell and the number of molecules per unit cell. The new tables appearing in the handbook of special interest to *Metals & Alloys* readers follows: X-Ray Crystallographic Data, 43 pages; Thermodynamic Properties, 14 pages; Heat of Combustion of Liquid Fuels, ½ page. RICHARD RIMBACH. (15)—B—

Journal of the Institute of Metals. Vol. LIII with index to Vols. LI, LII, and LIII. Institute of Metals, London, 1933. Cloth, 5½ x 8½ inches, 887 pages. The non-ferrous abstracts which have appeared monthly are here reprinted in bound form, just as they appeared monthly, without grouping all abstracts that come under a given heading, together. The index, however, allows finding the individual abstracts, and includes also the original articles published by the Institute during the year. H. W. GILLETT. (15)—B—

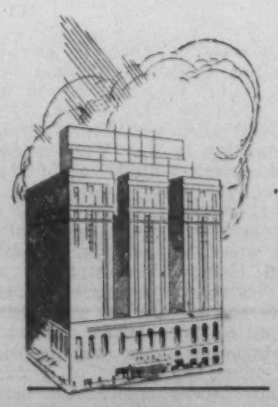
Journal of the Institute of Metals. Vol. LIV. Institute of Metals, London, 1934. Cloth, 5½ x 8½ inches, 326 pages. The original articles on non-ferrous metallurgy that have appeared in the first six months of 1934 are reprinted in bound form, with index. The presidential address of H. Moore points out that ferrous and non-ferrous metallurgy are interdependent rather than separate entities and mentions the benefit that would ensue from a coalition of the Institute of Metals and the British Iron and Steel Institute so that their articles and abstracts might be issued jointly. He also favors some plan of cooperation among the journals publishing metallurgical abstracts in English, a matter in which Metals and Alloys is also interested, and, with Dr. Moore, wishes that some workable scheme that would increase the completeness, accuracy, speed and usefulness of metallurgical abstract services, without raising their cost to the reader, could be evolved. The articles have been abstracted in our abstract section as they appeared monthly. The discussions, included here, add to the informative value of the articles themselves. That on the general subject of tarnish resistance of silver alloys, appended to the article on Ag-Be alloys is of special interest. The articles in general deal with the more theoretical aspects of non-ferrous metallurgy and the presidential address comments on the difficulty of persuading those who could write "practical" articles, to do so. H. W. GILLETT. (15)—B—

Economic (15a)

Uniform Extras and Deductions for Products of the Iron and Steel Industry under the Code of Fair Competition. Approved by the Board of Directors of *American Iron and Steel Institute*. 82 sections varying from 1 to 37 pages each. Loose leaf—paper binding. Published by American Iron & Steel Institute, New York. Price $1.00. Extras for special size, finish, analysis, testing, etc., for all commercial wrought ferrous products are stated. H. W. GILLETT. (15a)—B—

...HAVE YOU HEARD *the one about the traveling salesman?*

He went to bed at the William Penn and slept twenty years! Well, maybe that is a little exaggerated. But anyway, the beds at Pittsburgh's number one hotel are so comfortable you don't ever want to get up. The food in the four famous restaurants is equally exceptional, and the prices reasonable. Quiet, well-furnished rooms, $3.50 single; $5.00 double, all with bath.



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The French Tinplate Industry. *Tin*, Sept. 1934, pages 18-21. Report to (British) Department of Overseas Trade on development and present status in France and colonies. Ha (15a)

Tin Statistics. *Tin*, Sept. 1934, pages 14-16. World consumption and production according to countries is given for 1922-1933. Ha (15a)

Prices of Metallic Tin. *Tin*, Sept. 1934, pages 10-11. Daily movement, monthly and yearly averages since 1885 are given. Ha (15a)

The Preparation of Steel Bars. *Mechanical World & Engineering Record*, Vol. 96, July 27, 1934, pages 72-73. Description of a new plant for heat-treating, warehousing, cold drawing, and centreless grinding at the Vickers Works of the English Steel Corporation Ltd. Kz (15a)

A Modern Research Department. *Mechanical World & Engineering Record*, Vol. 96, July 6, 1934, pages 4-8. Description of the new laboratories of the United Steel Co. Ltd., at Stocksbridge, which provides facilities for every branch of research required for steel making and the development of steel products. Kz (15a)

Iron and Steel Imports of Palestine and Syria. *Iron & Coal Trades Review*, Vol. 129, Sept. 7, 1934, page 328. Statistics for different iron products for 1931-1933; imports almost doubled in this interval and are near 70,000 metric tons. No iron or steel is produced. Ha (15a)

Mineral Output of Great Britain in 1933. *Iron & Coal Trades Review*, Vol. 129, Sept. 28, 1934, page 466. Statistics for 1932 and 1933 of minerals used in the metallurgical industries are given. Ha (15a)

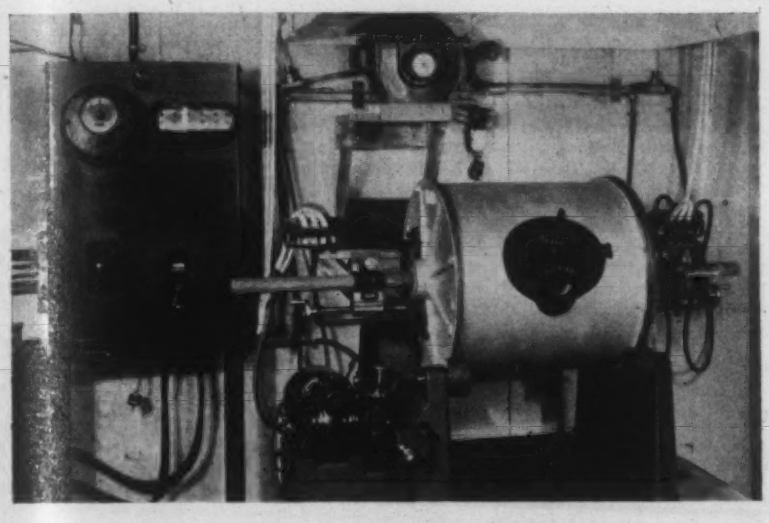
Chilean Iron and Steel Industry. *Iron & Coal Trades Review*, Vol. 129, July 20, 1934, page 87. Recent developments in the iron industry in Chile, ore deposits and plants are surveyed. Ha (15a)

The World's Iron & Steel Trade. *Iron & Coal Trades Review*, Vol. 129, July 27, 1934, pages 122-123. Iron and steel imports and export charts of 14 principal countries from 1929 to 1933, and of the 5 principal countries Great Britain, Germany, Belgium-Luxemburg, U. S. A., France, from 1909 to 1933 are given. Total world exports of iron and steel in both 1913 and 1925 amounted to 16 million tons, with a maximum of 20.6 millions in 1929. Economical conditions are discussed. Ha (15a)

NEW EQUIPMENT & MATERIALS

Electric Melting Furnace with Automatic Rocking Device

An electric melting furnace with automatic rocking device has been announced by Detroit Electric Furnace Company, Detroit, Mich. This new unit, designated Type GM, has been engineered to increase the angle of rock of the furnace shell automatically. The rate of increase may be changed—one rate being available for ferrous and another rate for non-ferrous materials. The new furnace is equipped with a special transformer and control panel. An oval shaped door is used instead of the square door. A feature of the rocking mechanism is that the shell velocity is zero at the point of reversal—despite the constant speed motor. This innovation makes for a quiet, smooth running machine. The shell is positively timed by a gear to the



reversing mechanism. Water-cooled electrode clamps insure a long life for these units. A special high temperature refractory is used and with interchangeable shells, the furnace is a satisfactory production or pilot unit for brass, iron or alloy steels. The unit is rated as 35 lbs. cold charge and 80 lbs. molten capacity. The manufacturers especially recommend the unit for experimental and test runs. The indirect arc, rocking action and atmospheric control make it especially effective where temperature and compositional control are important factors.

New Brazing Flux

A new flux to be called "Handy Flux," has just been announced by Handy & Harman, New York City. It has been developed to speed up and improve brazing operations on either ferrous or non-ferrous metals and is particularly appropriate for use with "Handy" Silver Solders and Sil-Fos and Easy-Flo Brazing Alloys—products of this company. It has a lower melting point than other fluxes used for the same purpose and permits taking full advantage of silver solders and brazing alloys having low flow points. Greater solvent action on a wide variety of oxides is said to be a feature that speeds up brazing and insures thorough wetting of joint surfaces at low brazing temperatures making it possible to obtain very strong and uniformly dependable joints. This new flux is made up in paste form ready for use. It works efficiently over a wide temperature range. It spreads rapidly over the work when heated with less tendency to ball up or bubble, avoiding bare spots or the blowing away of flux by the force of the torch flame and the consequent oxidation assuring an even distribution of the solder. The ordinarily hard to remove flux slags are no longer a problem when Handy Flux is used as they wash off readily with a little hot water. Handy Flux is recommended for brazing stainless steel, steel, monel metal, nickel, copper, brass, bronze and various other ferrous and non-ferrous metals and alloys. It is sold in one-half, one and five pound jars.

Tantalum Sheets .005-Inch Thick Now Welded by Electric Arc

Fansteel Products, Inc., Chicago, Illinois, has developed and perfected a method for welding this rare metal, thereby increasing its field of usefulness.

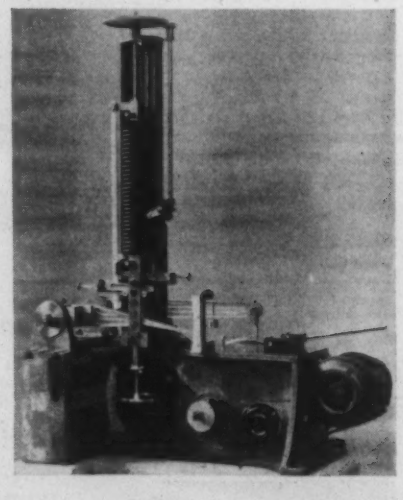
Exacting requirements covering the articles fabricated from tantalum have made it necessary to develop a special technique for welding it. Some of the most important factors which must be considered in working with this metal are as follows: 1. Tantalum is a very valuable metal, costing approximately $50 per pound—more than $3 an ounce; 2. Inasmuch as most of the articles are custom made, the labor cost is rather high. Spoilage must therefore be reduced to a minimum; 3. Finished welds must be strong, ductile and both gas and liquid tight under pressure and vacuum; 4. Tantalum cannot be deposited from an electrode without so embrittling the welds as to make them unusable; 5. Tantalum cannot be heated in air much above 650° F. without becoming hard and brittle; and 6. The melting point of tantalum is above 5100° F. The method finally adopted consists of first forming a straight angle flange at all edges of the sheets to be arc welded. These flanges are then fitted together and tack welded in a few places to avoid shifting the assembly. The job is then immersed in a tank filled with carbon tetrachloride so that the edge to be welded is approximately ¼ inch below the surface of the liquid.

Immersion in carbon tetrachloride requires higher voltage across the arc than would be needed to weld in air, and at the same time, the thinness of the stock being welded and the necessity for strict localization of the heat, demand low welding current. Hard carbon electrodes ⅛" in size, held in small light electrode holders, are used. The welding current must be of normal polarity. Stability of the arc and ease of striking it as well as freedom from blowing are absolutely essential for producing good welds. An open circuit voltage of 50 which falls to about 25 across the arc usually produces satisfactory welds. Current depends on the thickness of metal, .005-inch stock requiring only 15 amperes and .025-inch 60 amperes.

Welding is accomplished by melting the edges of the flanges so that the metal runs together. This must be accomplished quickly since holding the arc in one spot or striking it more than once in one place, is likely to result in brittle welds. Welding equipment manufactured by The Lincoln Electric Company, Cleveland, Ohio, is used in this work.

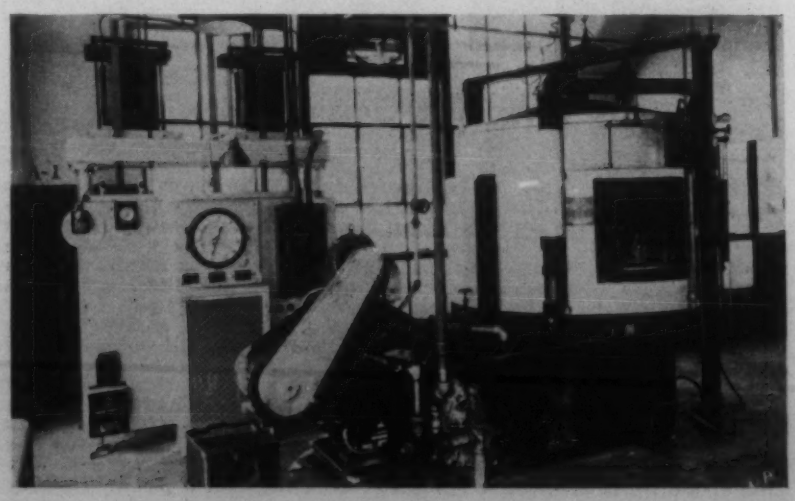
New Torsional Fatigue Testing Machine

Dr. Alfred J. Amsler has developed a new machine for torsion fatigue tests, under the application of repeated or reversed torsional stresses, capacity 500 ft.-lbs. The machine produces torsional vibrations in a specimen between two adjustable limits which may be chosen in such manner that the specimen does not undergo any permanent deformations until the fatigue limit has been reached. These tests should be carried out well below the torsional elastic limit, since otherwise the results do not depend upon the true fatigue properties of the material. The test bar can be pre-loaded in one direction, and the torsional vibrations are then superimposed. If the test piece, without pre-loading, is to be stressed alternately in two directions, the angle of deformation must be equal to both sides. An adjustable crank-lever deflects the test bar in torsion by a definite angle. The other end of the bar is connected to a lever which serves to indicate the stress applied, by a large measuring spring. A scale, reading directly in ft.-lbs., is provided. The lower and upper limits of load can be controlled during a test. If, during a test, the specimen should undergo a permanent deformation, the machine, automatically, maintains a constant amplitude of torsional vibration. If the specimen breaks, the machine stops automatically. An automatic counter indicates the stress-cycles to fracture. Two interchangeable load ranges are provided; 500 and 250 ft.-lbs. The machine operates at 1000 or 2000 cycles per minute. This machine is sold through Herman A. Holz, 167 East 33d St., New York.



Rotary Hearth Type Furnace for Small Parts

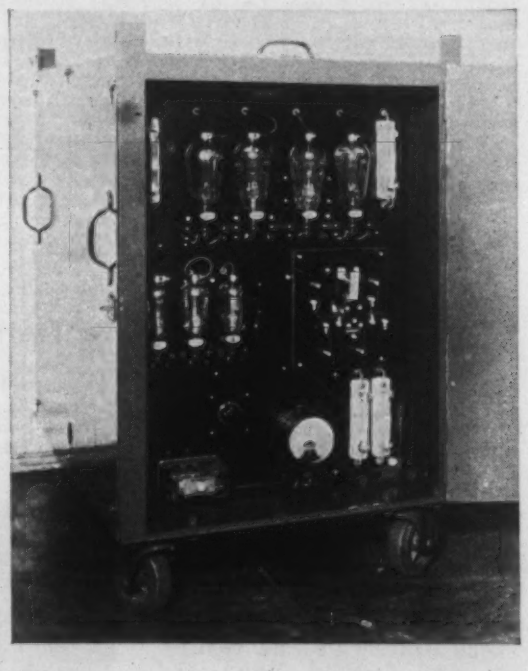
A small rotary hearth type furnace for the economical heat treatment of miscellaneous lots of small and medium size products has recently been developed and built by The Electric Furnace Company, Salem, Ohio. The material is charged



onto tilting trays by a sliding bottom loading pan, carried around the furnace on an alloy hearth, heated to the necessary temperature and dumped through a chute to a water or oil quench. With this furnace the handling of small lots of miscellaneous small and medium size products is placed on a continuous and economical basis. This furnace is specially adapted for the handling of springs, bolts and miscellaneous machine screw products. The accompanying photograph shows the charging door of the furnace, quench tank, conveyor, recording controllers, etc. The transformers are shown mounted above control panel.

Ignition Welding Timer

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announce the details of a recent development — a portable Ignition Welding Timer, for accurate timing of all types of resistance welding machines. It is claimed to be so accurate in timing that it will pass electrical current for periods as short as one cycle (1/60 second) and is adjustable up to 30 cycles (½ second). Accurate timing has been found to be important in the fabrication of aluminum, aluminum alloys and high strength steels. Outside of its electrical advantages over former types of equipment, it is very light in weight and small in dimensions so that it is extremely portable—it is only 46" high, 42" long and 29" wide and weighs approximately 700 lbs. A unit of this size will carry electrical energy in magnitude as high as 700 kv-a, 440 volts single phase.



Temperature-limit Control for Furnace Roofs

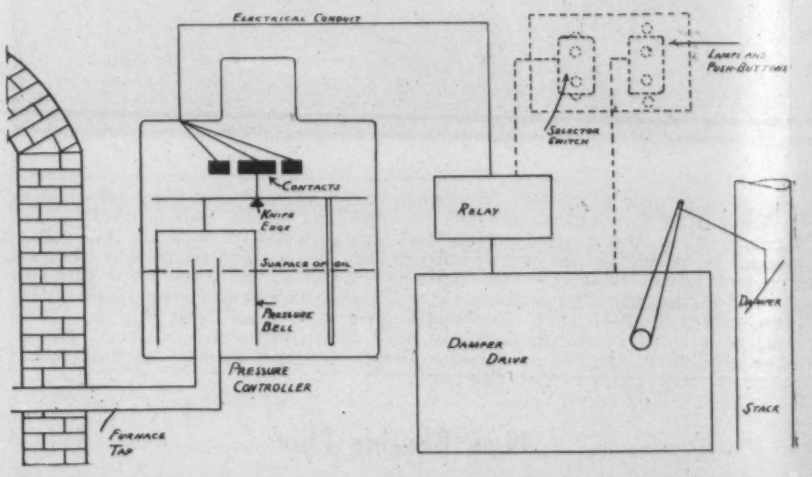
Automatic fuel cut-down or cut-off, based on measurement of temperature of carborundum block without physical contact, is the principle employed in this new system brought out by the Leeds & Northrup Co., Philadelphia, Pa. Overheating of furnace roof being prevented, the operator can run his furnace up to its highest safe temperature without fear that the roof will be damaged should his attention be diverted. The number of heats per roof is said to be noticeably increased. *Parts:* (1) Carborundum block of special design, with well drilled to 1" of bottom. May be installed when roof is being built or while furnace is hot. Lasts for an entire campaign: should bottom burn away, a special plug is dropped in well. (2) Thermotube employing familiar mirror-and-thermocouple principle but of new design with water jacket which serves as mounting. (3) Instrument is 1400°-3200° F., 24-hour round-chart "Micromax" potentiometric recorder-controller with wide indicating pointer and 12" large-figured "giant" outer scale. (4) Motorized valve: as required but always of simple, strong type, as it operates only in emergencies.

New Blast Cleaning Unit

W. W. Sly Mfg. Co., Cleveland, Ohio, announce a new cleaning unit. The blast principle of the new unit is one of utilizing many times more abrasive grains with a resulting proportionate increase in the number of impacts upon the surfaces to be cleaned. This comparatively large volume of abrasive is fed into an air stream from a high pressure fan blower, the wheel of which is mounted direct on the shaft of a ball bearing motor. The kinetic energy of the blast is imparted to the abrasive grains. The abrasive does not pass through the blower, eliminating all wear on the blower. The first application of this new blast principle is in connection with a blast mill, the barrel of which has an inside diameter of 42" and a length or depth of 36", revolving on an inclined axis. Its design permits running the mill at low speed for delicate work and at higher speeds for other work. The tumbling action can therefore be combined with blast cleaning on a great variety of work for obtaining a tumbled and blasted finish in a single operation. The mill barrel has a load capacity of from 10 to 15 cubic feet. Its tilted position insures a thorough mixing of the load, and the blast is directed against the center of the load face, at its greatest depth, for most effective cleaning results. The barrel is perforated and surrounded by an outer shell which receives the used abrasive and by means of a spiral flight, returns it to the high end with every revolution of the barrel. Buckets fixed to the inside of this outer shell lift the abrasive and return it to a feed hopper above the blast nozzle. The mill barrel with its outer shell and spiral and buckets is a self-contained unit revolving as a single piece. This one-piece construction means the absence of friction between parts and the practical elimination of wear from the cutting and grinding action of abrasive, refuse, etc. There are no moving parts inside the blast chamber. Operating cost is claimed to be low because of the entire elimination of compressed air and the small amount of power needed for producing the blast from the fan blower. Maintenance cost is negligible because the abrasive does not pass through the blower, and the barrel is a one-piece unit which tumbles the work and returns the abrasive.

Furnace Pressure Control

In operating open-hearth, billet heating and other types of furnaces, operator's attention is engaged by numerous factors, so that he cannot constantly regulate pressure. This system, brought out by the Leeds & Northrup Co., Philadelphia, Pa., relieves him entirely of this duty. It consists of a compensated inverted-bell type element with single or double limit contacts commanding a damper motor through a relay, with red and green signal lamps and means for changing over from automatic to manual control. Furnace pressure controller has micrometer adjustment device and normal range of +0.05 to —0.10 in. of water, variable



by shifting weight on balance arm. When automatic regulation reaches either of its limits under extreme conditions, one of the colored lamps flashes, signaling furnace operator who then switches from automatic to manual and operates damper himself from a push-button station. Damper drives are available with output torque and other characteristics suited to application, standard motor being ⅛ h.p.; 115 or 220 volts d.c., or 110 or 220 volt 3-phase 60-cycle a.c. Controller, relay and damper drive are all in heavy dust-proof cases. Recommended installation is controller, selector switch, lamps, push-button station and relay cabinet all on one panel so located that pipe from furnace tap to controller will not accumulate water.

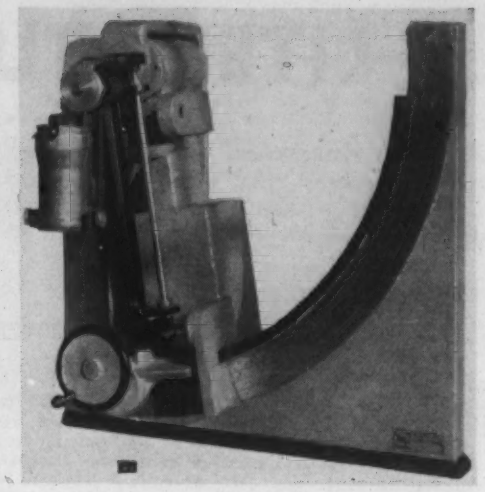
Scrap Metal Baling Press

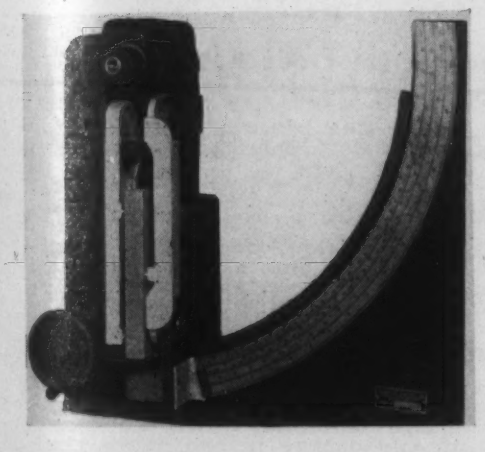
A recent development of The Hydraulic Press Mfg. Co., Mount Gilead, Ohio, is a box type scrap metal baling press. The H-P-M baling press is completely self-contained with its motor driven H-P-M hydro-power unit mounted directly on the press at one end. The press consists of a box built up of massive ribbed steel castings to take the loose scrap metal. It is closed by a heavy sliding door, actuated by a hydraulic cylinder. Pressure is applied to the scrap from two directions—first from the end, and then from the side by platens moving into the box operated by hydraulic rams. The application of the pressure is controlled through three lever actuated valves. Two pumps, each of the rotary high-speed oil pressure type, build up the pressure. The first pump delivers a large volume of oil at medium pressure; the second pump, the new H-P-M variable delivery radial type builds pressure up to maximum. An H-P-M control automatically regulates the pump's pressure and volume of output. Compactness, smooth action, speed of operation, ease of control and bales of high density are among the desirable features of this new H-P-M scrap metal baler.

Sand Testing Instruments

The following instruments are all manufactured by Harry W. Dietert Co., Detroit, Mich. The tensile sand strength accessory consists of 2 major parts, the tensile specimen tube holder and the loading mechanism. The ten-

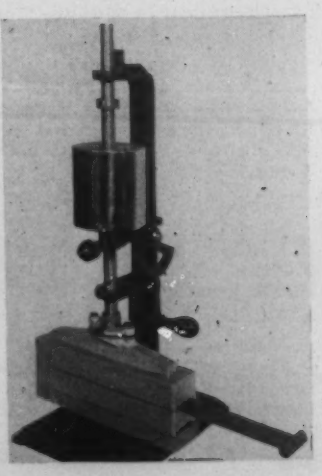
sile tube holder bolts to the pivot shaft of the Type C. P. strength machine. A hardened steel base with the aid of 2 clamping screws holds the tensile specimen tube rigidly in place during the test. The loading mechanism is mounted on an aluminum frame having 2 hardened studs which enter the upper and lower test position holes of the pusher arm of the strength machine to hold it in position. A steel shaft mounted on dust protected ground ball bearings supports the pendulum weight on its lower end. On the upper end of the shaft the load is transferred through a bronze ball chain to the upper half of the sand specimen in the tensile specimen tube. The tensile specimen tube as furnished with this accessory consists of 3 parts, namely, tube proper, specimen grip and cup pedestal. The tube proper is made of a thick wall brass casting accurately machined to size. The specimen grip which holds the upper half of the sand specimen seats itself into the tube proper on a self-freeing taper thus eliminating friction and binding due to grit. The cup pedestal fits around the bottom of the tube holding specimen grip in place while ramming the sand in the tube. The sand sample is placed in the tensile specimen tube and rammed. The cup pedestal is then removed and specimen tube is attached to tensile test accessory. The sand specimen is loaded by turning hand wheel of Type C. P. strength machine and recording maximum dry shear scale reading as grams tensile strength.

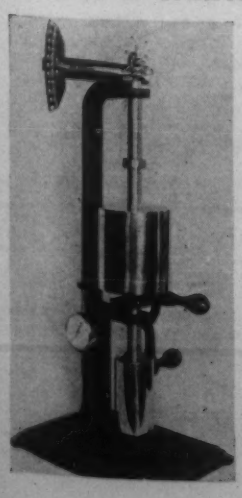




The transverse core strength accessory consists of 2 parts, a double core support arm and a single core support arm. The double support arm is attached to the pusher arm of the strength machine, while the single support arm is attached to the loading weight of the strength machine. The supports on the double support arm are pivoted to secure alignment with core specimen. All of the supports and attaching studs are hardened. The load on the core specimen is read directly from the dry shear scale of the strength machine.

The transverse strength core box consists of the following parts. A hardened steel faced aluminum cross head with attaching clip for rigidly attaching cross head to the plunger of sand rammer. A sand hopper to hold the surplus of core sand. A spring steel cut-off knife to accurately and easily size core to the one inch height. A two part aluminum core box allowing easy removal of core from core box. Core drying plates on which core specimens are rammed and by which they are handled before baking. A steel anvil forming a support for the core box assembly. A strike-off template used to level core sand in sand hopper. Cores as rammed with this equipment are suitable for either research or control test.





The flowability indicator consists of a dial indicator of special construction calibrated to read in percentage of flowability. It is attached to the sand rammer by means of 2 screws. The indicator stem rests against the cross head of the rammer and registers the movement of the rammer plunger between the fourth and fifth drop as flowability. The flowability of molding sand is influenced by moisture content, permeability, fineness, clay content, strength, and facing material additions. It may be controlled by increasing or decreasing any one of the above physical properties until suitable flowability is secured. A molding sand with a flowability of 90 will ram readily and is inductive to producing a uniform casting surface, while a sand with a flowability of 75 will require more ramming energy and is inductive to inferior casting surfaces.

The Cromodine Process

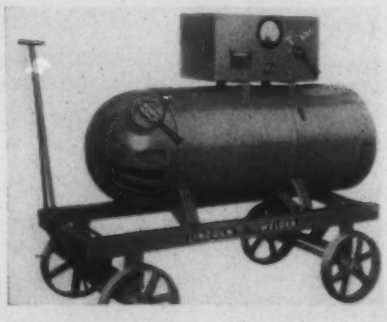
The American Chemical Paint Company has recently developed a process in which cleaned steel surfaces are conditioned, or treated, so that when painted, the life of the finishing materials is extended, without impairing the luster of the applied finishes. The process is a conditioning process, not strictly a coating process, in that a coating of appreciable thickness is not produced. This is claimed to have a very decided advantage in that not only is the paint firmly attached to the surface, but there is no coating which has a tendency to peel or flake upon bending. The company supplies a crystalline material known as "Cromodine." This is dissolved in water contained in a stainless steel tank, heated with coils to a temperature of 170° to 180° F. In addition to this Cromodine tank, 2 rinse tanks are required. These can be constructed of steel or wood. The first one contains cold water, which overflows freely, and the second one contains hot water. The process consists in first removing the oil and rust from the surface. Oil is best removed by an alkaline cleaning process, and rust is removed either mechanically, with an abrasive, or chemically. The parts are then immersed into the heated Cromodine solution, in which they remain for a minute. They are then removed and rinsed in a tank of cold running water, and then, by immersing them into a bath of hot water, the drying of the surface is hastened. A powdery residue is left, which in most cases should be removed by a tack rag wipe, after which the surface is ready to receive the prime coat of paint. The Cromodine process provides an excellent foundation for high bake enamels as well as synthetic materials and oil primers. The cost of the process is approximately 10c per 100 square feet of surface coated, and the time being so short, adapts the process to large as well as to small production.

Protected Metal Now Covered With Copper

The H. H. Robertson Co., Pittsburgh, Pa., announces that the standard Robertson Protected Metal is now covered with Anaconda "Electro-sheet" copper. The exterior surface consists of copper firmly bonded to asbestos felt, which in turn is applied to the steel core sheet with asphalt.

New Alternating Current Welder

The Lincoln Electric Company, Cleveland, Ohio, announces a new alternating current welder which will be known as the Lincoln "Shield Arc AC." This new welder is of the motor generator type which takes 2 phase or 3 phase alternating current of standard voltages and frequencies and converts it into alternating current of lower voltage and at that higher frequency most suitable for arc welding with either heavily coated or washed electrodes in all positions. This principle, exponents of a.c. welding say, is an innovation which makes the new type of machine the most commercially practical type. For this equipment, the manufacturer claims the following advantages over the usual a.c. transformer type of welder: (a) Improved arc characteristics due to the higher frequency such as more stable arc, less magnetic blów, easier starting of arc. (b) Improved weld metal since there is less spatter loss and in multiple pass welding greater density. (c) Better power characteristics from the line. Since the machine takes power from all phases instead of from one phase, unbalancing of phases is eliminated and a power factor of approximately double that of the transformer type is obtained. Since this type of welder draws from the line balanced power at lower amperage and higher power factor, the regulation of the transmission equipment is materially improved over that of the usual transformer type. The new "Shield Arc A.C." welder is built in portable and stationary a.c. motor driven models in 2 sizes. The smaller capacity machine can be used for continuous welding with electrodes of 3/32" to 5/16" in size; the larger capacity welder handles electrodes from ⅛" to ⅜" in size. These machines are wired for 220, 440 or 550 volts, a.c. supply, 2 or 3 phase, 50 and 60 cycles. In appearance, size and weight the "Shield Arc A.C." is almost identical with its companion, the "Shield Arc" machine for d.c. welding. The manufacturer also claims that according to actual test the current drawn from the line by this machine is no more than that drawn by the usual d.c. motor generator type and is a fraction of that drawn by the transformer type.



Metal Bags

The successful large-scale manufacture of flexible metal bags for perishable food products has finally been accomplished, according to a recent announcement made by the Reynolds Metals Company, manufacturers of metal foil products. Although long recognized as desirable for maintaining quality in perishable food products, metal bags have not heretofore been widely used, due to the difficulties encountered in quantity-production. Recently, special bag making equipment, has overcome the chief drawback to the popularization of this packaging medium. Metal bags, composed of finely-rolled metal, mounted to a variety of papers, combine the light and moisture protection of the metal container, with the flexibility and economy of popular flexible wrapping materials. The light-proof and moisture-proof features of the metal bag make it particularly applicable to the packaging of potato chips, nuts, candy, prepared flour, cereals, and other food products subject to deterioration through rancidity, moisture-absorption, moisture-loss, and insect infestation.

MANUFACTURERS' LITERATURE

Note: (This department is conducted for the convenience of the readers of METALS & ALLOYS *desiring to add to their files copies of current literature issued by manufacturers. Any items desired can be secured free by applying direct to the issuing firms or in those cases where a number of items are wanted applications may be sent direct to this office. A coupon is provided on which the numbers of the items required can be listed.)*

Fire Brick For Every Purpose

Leaflet illustrating and describing six famous brands of fire brick in standardized 9 inch clay fire brick shapes. Laclede-Christy, St. Louis, Mo. (535)

Production Welding

Booklet on the subject indicated containing a wealth of interesting data. The Linde Air Products Company, 30 East 42nd Street, New York, N. Y. (536)

The Metallurgy of Wire Manufacture

A paper presented to the Worcester Chapter of the American Society for Steel Treating by H. W. Graham, General Metallurgist of Jones & Laughlin Steel Corporation. Contains valuable and interesting data, manufacturers' standard specifications, tables, etc. Jones & Laughlin Steel Corporation, Pittsburgh, Pa. (537)

Cupola Refractories

Paper presented at the 1933 convention of American Foundrymen's Association, Chicago. Contains much useful and valuable information on the subject indicated. The Ironton Fire Brick Co., Ironton, Ohio. (538)

Look to the Ingot for Quality in Steel

Booklet on the subject indicated, illustrating and describing ingots. The Gathmann Engineering Company, P. O. Box 43, Carroll Station, Baltimore, Md. (539)

Eastern Steel Castings

Pamphlet illustrating and describing electric, open hearth and alloy steel castings up to 10,000 pounds. Eastern Steel Castings, Avenue L and Edward Street, Newark, N. J. (540)

Mo-lyb-den-um in Cast Iron

Brochure of up-to-date information to foundrymen containing much new information on the applications of molybdenum in the iron foundry. Contains photomicrographs, tables, charts, curves, etc. Climax Molybdenum Co., 295 Madison Avenue, New York, N. Y. (541)

Mayari Staybolt Steel

Pamphlet describing higher boiler pressures without increased staybolt trouble, Bethlehem Steel Company, Bethlehem, Pa. (542)

New Method Annealing

Pamphlet containing data on this method of annealing. Illustrated. Power curves, comparison of annealing costs, etc. The Bellis Heat Treating Co., Branford, Conn. (543)

Nozzle and Stopper Rod Assemblies

Paper By H. V. Beasley, reprinted from *Blast Furnace & Steel Plant* issues of October and November, 1933. Vesuvius Crucible Co., Swissvale, Pa. (544)

Recording Electrical Instruments

Bulletin No. 416, illustrating and describing volt meters, millivolt meters, ammeters, shunt ammeters, wattmeters, frequency meters. The Bristol Company, Waterbury, Conn. (545)

Pyrometers

Bulletin 414 illustrates and describes pyrometers for controlling, recording, indicating, temperatures up to 3000° F. The Bristol Company, Waterbury, Conn. (546)

The Airco-D-B Oxygraph and Travograph

Brochure illustrating and describing No. 6 Oxygraph, No. 7 Oxygraph and No. 1 Travograph. Air Reduction Sales Company, 60 East 42nd Street, New York, N. Y. (547)

USS Stainless and Heat Resisting Steels

A treatise prepared under the direction of the Committee on stainless and heat resisting steels, subsidiary manufacturing companies of the United States Steel Corporation. A very handsome volume containing a wealth of information. American Sheet & Tin Plate Co., Pittsburgh, Pa.; American Steel & Wire Company, Chicago; Carnegie Steel Company, Pittsburgh, Pa.; Illinois Steel Company, Chicago, Ill.; National Tube Company, Pittsburgh, Pa. (548)

Corrosion & Heat Resisting Steels

A new crucible steel catalog on corrosion resistant steels. The 80-page catalog is also a manual in regard to physical and chemical properties and methods of use. Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y. (549)

Multiple Tables in Convenient Form

The Timken Steel & Tube Co. has just published a series of tables which will be both convenient and helpful to all who have occasion to use steel in multiple lengths. Ten convenient and simple tables in this booklet enable the steel user to tell at a glance either how long his stock must be to furnish a definite number of multiples, or how many multiples can be cut from a given length of stock. The tables cover multiples up to 50 in number from 1 to 60 inches in length, including common fractions to 1/64 inch. The Timken Steel & Tube Co., Canton, Ohio. (550)

Operating Manual for Plating with Duozinc

Technical information on zinc-mercury plating is made available in a new and enlarged edition. The data given in the manual cover in general all phases of Duozinc plating, including preparing the material for plating, making up the solution, operation, analyzing the solution, testing the deposit, and other details. R. & H. Chemicals Dept. of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (551)

Copper Covered Robertson Protected Metal

Just off the press, a new folder illustrating and describing standard Robertson Protected Metal with the addition of the beautiful and durable Anaconda "Electro-Sheet" copper on the outside. This surface is in itself a relatively new product which the American Brass Company is introducing to the market for various purposes. H. H. Robertson Co., Grant Bldg., Pittsburgh, Pa. (552)

53 Years Successfully Solving the Production Demand for Economy Plus Quality

Leaflet describing and illustrating heating equipment for steel treating on a production basis. American Gas Furnace Company, Elizabeth, N. J. (553)

Allegheny-66

Bulletin 66 sets forth data on this chromium-steel alloy used extensively for nitric acid plants and equipment. Table of laboratory tests, analysis, physical data, etc. Joseph T. Ryerson & Sons, Inc., Boston, Mass. (554)

The Moore Rapid 'Lectromelt Furnace

Bulletin F illustrates and describes in detail this type of furnace which is claimed by the manufacturer to be extremely rapid in operation and will melt down, alloy and superheat rated capacity of cold charge in one hour's time when making alloy iron or steel with a good grade of scrap and ample power available. Plan view and side elevation of 'Lectromelt Furnace. Pittsburgh Electric Furnace Corp., Pittsburgh, Pa. (555)

Hydro Automatic Furnace

Catalog setting forth data on this furnace for cyanide hardening and heat treating by other liquid bath processes. Illustrated. Parker-Kalon Corp., 200 Varick Street, New York, N. Y. (556)

Misco

Leaflet describing the above line of stainless heat resisting corrosion resisting alloys. Illustrated. Michigan Steel Casting Co., Detroit, Mich. (557)

A Busy Boiler

Leaflet illustrating and describing Kane Automatic Gas Boilers for process steam. Mears-Kane-Offeldt, Inc., 1903 East Hagert St., Philadelphia, Pa. (558)

Weldless Tires & Rings

Catalog with complete data on Midvale steel tires, steel tired wheels, weldless rolled steel, roll shells, ring dies, grinding rings, forged steel rings, with some useful tables for users of these products. The Midvale Company, Nicetown, Pa. (559)

Thermit Pure Carbide-Free Metals

Booklet containing data on ferro titanium, chromium, manganese, titanium manganese copper, pure carbide-free manganese. Metal and Thermit Corp., 120 Broadway, New York, N. Y. (560)

Stronger Than Steel

Bulletin No. 4 sets forth data on these aluminum bronze die castings for metal parts in modern products. Illustrated. Aurora Metal Company, Inc., 614 West Park Avenue, Aurora, Ill. (561)

Photomicrographic Cameras

Booklet illustrating and describing a selection of Spencer cameras. Spencer Lens Company, Buffalo, N. Y. (562)

Ladle Sparks

Interesting booklet, Vol. 1, No. 4, contains an article entitled "Which Cast Steel Shall I Use?" This article is designed to show how the proper alloying and heat-treating of steels can assist the engineer and manufacturer in their constant search for better materials at lower, or competitive, costs. Sivyer Steel Casting Co., Milwaukee, Wis. (563)

Norbide

Booklet describing Norton Boron Carbide the new material claimed by the manufacturers to be the hardest material ever produced by man for commercial use. Norton Company, Worcester, Mass. (564)

Temperature-Limit Control for Furnace Roofs

Application Bulletin No. 53-116 (1934) sets forth complete data on this subject. Illustrated. Mounting dimensions. Equipment specifications. Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, Pa. (565)

Castings That Suit the Purpose

Handsome booklet setting forth complete information on Monel metal, nickel and high nickel alloys to meet all conditions. Profusely illustrated. The International Nickel Company, Inc., 67 Wall Street, New York, N. Y. (566)

Widia Cemented Carbides

Just off the press, handbook and catalog on Widia cemented carbides as used in tools, wear-resisting parts, and other similar applications. 24 pages and cover. Profusely illustrated and several pages are devoted exclusively to photographs showing some recent applications of Widia cemented carbide to various special tools, such as intricate cutters, as well as various wear-resisting parts which do no cutting—for instance, sand blast nozzles, centerless grinder rests, thread guides, electrical contact points, etc. Thomas Prosser & Son, 15 Gold St., New York, N. Y. (567)

Buckeye Silica Firestone

Bulletin No. 15 describes split rock linings for refractory purposes. Illustrated. Diagrams of tests and miscellaneous information. The Cleveland Quarries Company, Cleveland, Ohio. (568)

Refrak Screen Burners

Attractive booklet descriptive of this type of burners. Typical applications, specifications and dimensions. Capacity table. Installation drawings. Capacities of orifices. The Selas Company, Philadelphia, Pa. (569)

"Nothing is Impossible to Industry"

Leaflet descriptive of complete units for oil or gas using special composition cast pots. The Campbell-Hausfeld Co., Harrison, Ohio. (570)

Arc Welding Machines

Booklet setting forth facts regarding Airco-Wilson arc welding machines. Illustrated. Manufactured by Wilson Welder and Metals Co., Inc. Distributed by Air Reduction Sales Company, 60 East 42nd Street, New York, N. Y. (571)

Carbon Arc Welding and Cutting

Interesting data on this subject by W. J. Chaffee are contained in an attractive booklet, issued in 1934. Illustrated. The Hobart Brothers Co., Box DM-296, Troy, Ohio. (572)

F C C

Handsome booklet illustrating and describing composite steel die sections. Tables of iron and steel measurements and weights, instruction sheets, properties and applications, etc. The Forging and Casting Corp., Ferndale, Mich. (573)

Sheet Iron Primer

Bulletin 127 contains 64 pages and is profusely illustrated. In simple, non-technical language it tells the step-by-step story of modern manufacture of sheet iron, tracing production from the ore mine to the final inspection of the completed sheet. It contains gage tables and an interesting glossary of metallurgical terms. Republic Steel Corporation, Massillon, Ohio. (574)

Spencer Turbo-Compressors

Attractive and comprehensive booklet for the foundryman on the subject of these compressors for foundry cupolas. Illustrated. Performance curves. Table of capacities. Sectional view of compressor. The Spencer Turbine Co., 521 New Park Avenue, Hartford, Conn. (575)

Weld It Well!

Bulletin No. HW-3 illustrates and describes the P & H "Hansen" Arc Welder. Set forth also are a dozen points of distinction claimed for this welder by the manufacturers. Tables, cross sections, etc. Harnischfeger Corp., Milwaukee, Wis. (576)

Carbofrax Veneered Arches

Booklet No. 3 sets forth complete data on this subject. Illustrated. Method of application. The Carborundum Company, Perth Amboy, N. J. (577)

Perliton Liquid Carburizer

New booklet containing graphs and microphotographs illustrating the results obtained with this carburizer. The data set forth in this book are claimed by the manufacturer to be the results of actual tests in the field and not merely laboratory experiments. E. F. Houghton & Co., 240 West Somerset Street, Philadelphia, Pa. (578)

Olympic Bronze

Brochure announcing a high copper alloy containing silicon and zinc designed especially for structural and engineering purposes. Tables, charts, photomicrographs, etc. This publication constitutes a hand book covering properties and uses of Olympic Bronze. Chase Brass & Copper Co., Incorporated, Waterbury, Conn. (579)

Dolomite Refractories

Basic Dolomite, Incorporated, has issued a most interesting and attractive pamphlet which presents the case of Clinkered vs. Calcined Dolomite in the basic open-hearth steel furnace. The conclusion reached is that the clinkered product is more economical and in addition provides an easier working furnace and closer control upon refining. Basic Dolomite, Inc., Hanna Building, Cleveland, Ohio. (580)

Ductillite

Handsome brochure descrjbing Ductillite, the pioneer of modern tin plate. Many illustrations and interesting data on this product. A valuable addition to the library. Wheeling Steel Corporation, Wheeling, West Virginia. (581)

Superior Charcoal Pig Iron

Interesting little booklet setting forth history, characteristics, grades, brands, also contains grading card, furnaces and capacities. Superior Charcoal Iron Company, Grand Rapids, Michigan. (582)

Dust Filters

Bulletin No S-76 sets forth full information on dust filters. Construction features, cross section, many illustrations showing installations, etc. The W. W. Sly Manufacturing Co., 4700 Train Avenue, Cleveland, Ohio. (583)

METALS & ALLOYS, 330 West 42nd St., New York, N. Y.

I should like a copy of each piece of Manufacturers' Literature listed below.

.....

Name .....

Position ..... Firm .....

Street and Number .....

City ..... State .....

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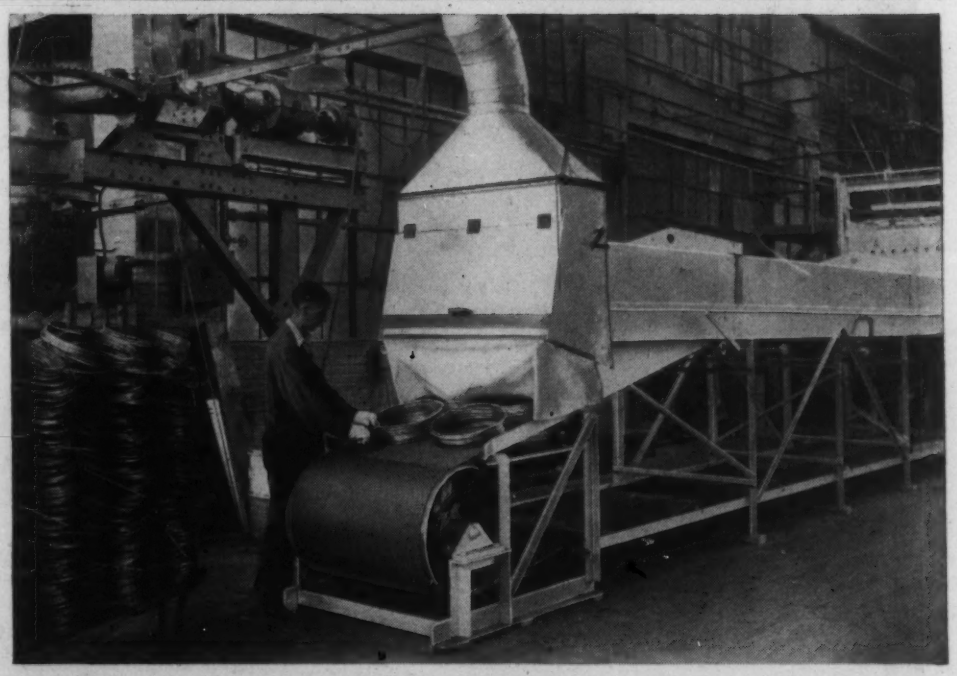
How Wolverine Tube Co.

IMPROVED QUALITY
INCREASED SALES
CUT HEAT-TREATING COSTS 50%
with a G-E ELECTRIC FURNACE

"WE'RE mighty proud of our new G-E furnace which bright-anneals our copper tubing," says President C. C. Limbocker of the Wolverine Tube Company, Detroit. "It is helping us to increase sales because it has materially improved quality. Our tubing is now more uniform, and as a result of the dry-annealing feature of the furnace, water spotting has been entirely eliminated. Our annealing costs have been cut in half. The cost of electricity per pound of tubing annealed is only one-tenth of a cent."

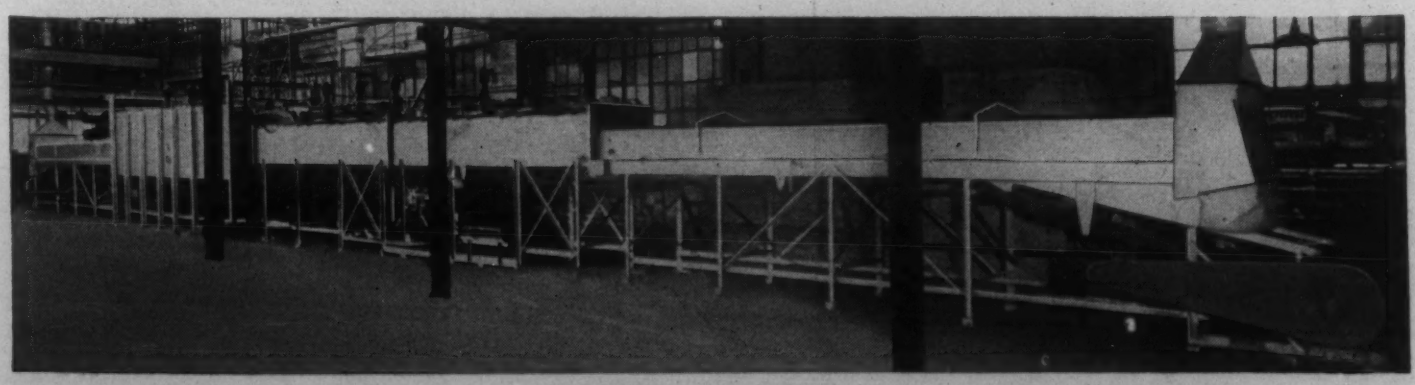
"With this new furnace we are able to give our customers quick shipment on small orders. Its flexibility is outstanding. It handles all our products — straight and coiled tubing, finned tubes, and formed pieces; whereas before we installed it, three furnaces were required."

You may not be a tube manufacturer, but if you heat-treat your product, it will pay you to investigate our complete line of heat-treating furnaces. For complete information, call the nearest G-E office; or address General Electric, Dept. 6B-201, Schenectady, N. Y.



This is the charging end of the Wolverine Tube Co.'s new G-E controlled-atmosphere, continuous, mesh-belt-type heat-treating furnace. This furnace cut annealing costs 50 per cent

Your best sales appeal today is high quality — your best assurance of high quality is electric heat-treatment

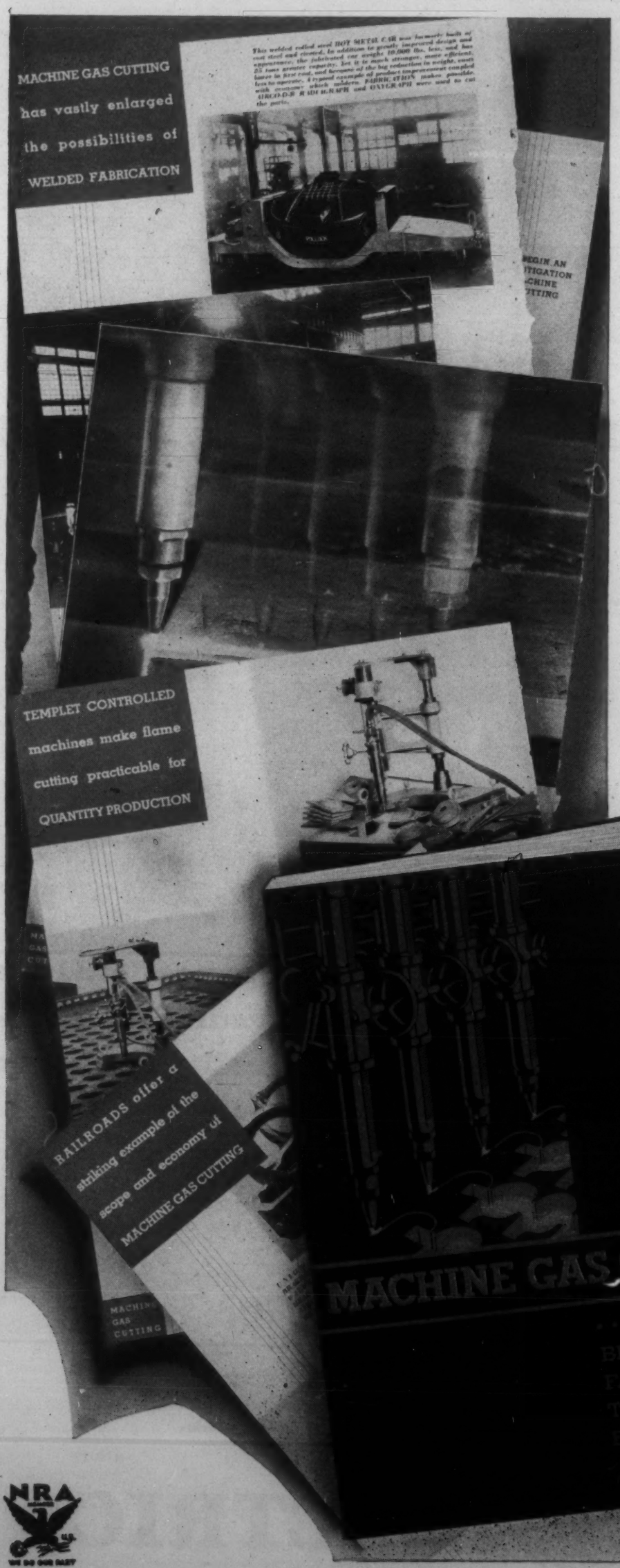


The atmosphere for this furnace is supplied by a G-E furnace-atmosphere controller which re-forms a mixture of air and city gas

170-18

GENERAL ELECTRIC

Put MACHINE GAS CUTTING on your 1935 COST CUTTING PROGRAM



In making plans for 1935, manufacturers of ferrous metal products should give careful consideration to MACHINE GAS CUTTING, a process laden with possibilities for improving design, speeding up production and effecting great economies in the making of steel parts of almost every description, and in the modern practice of welded fabrication.

AIR REDUCTION SALES CO. is ready to aid individual manufacturers in determining whether MACHINE GAS CUTTING can be profitably employed, and if so, where and to what extent. Call on us without hesitation for there is no obligation involved.

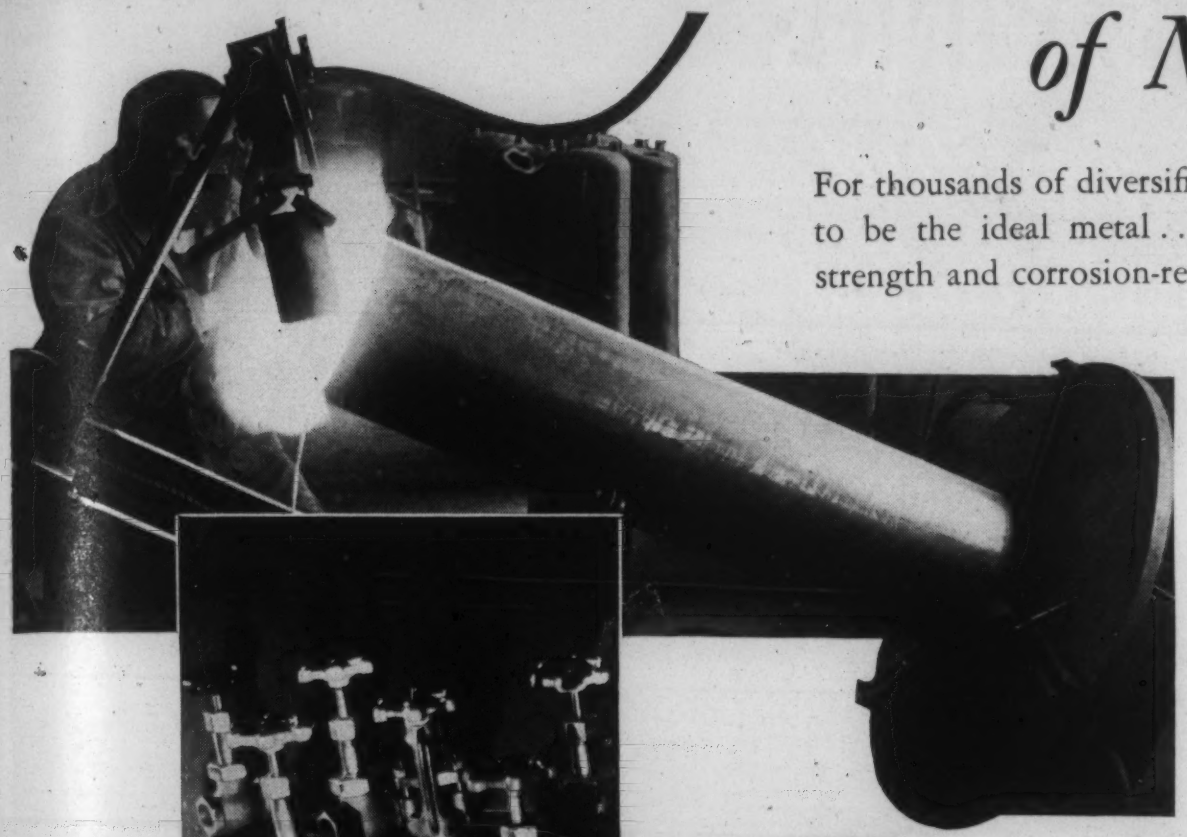
AIR REDUCTION SALES CO.

General Offices: 60 East 42nd St., New York, N. Y.
District Offices and Distributing Stations in Principal Cities

..Send for this book

Production executives of metal working companies are invited to write for this 92-page book in which the story of MACHINE GAS CUTTING is fully told. Numerous examples from every day usage, strikingly illustrate the possibilities of the process. AIRCO'S complete line of machines are illustrated and described. Your request on your business letterhead will bring you a copy.

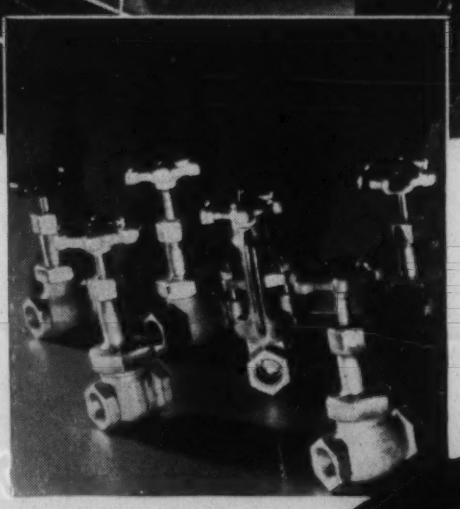
EVERDUR...*Modern Metal of Many Uses*



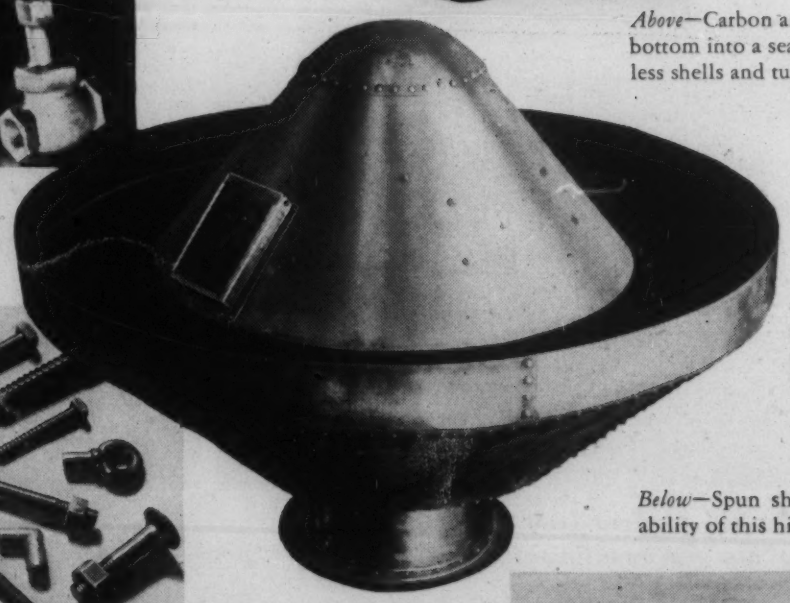
For thousands of diversified uses, Everdur has proved to be the ideal metal . . . because it combines high strength and corrosion-resistance with ductility, weldability, workability and moderate price.

"Everdur" is a registered trade-mark identifying products of The American Brass Company made from alloys of copper, silicon and other elements. Additional information upon request.

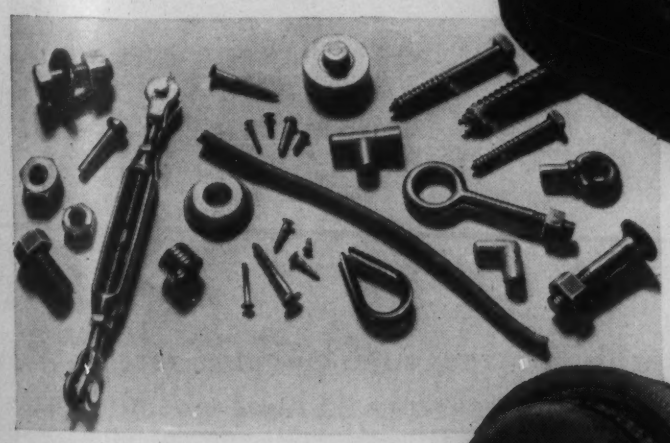
Above—Carbon arc welding an Everdur storage tank bottom into a seamless drawn Everdur shell. (Seamless shells and tubes available up to 26" I.D.)



Above—Cast Everdur valves for severe service. Everdur ingots are used for a wide variety of dense close-grained castings—made with the regular equipment of brass and bronze foundries.



At left—Excellent resistance to dilute sulphuric acid, plus high strength and good fabricating qualities, makes Everdur ideal for smoke washers.



Below—Spun sheet Everdur. No end to the adaptability of this high-strength copper-alloy!

Above—Here we have forgings, die-pressings, machined parts, rolled parts and flexible metal tubing. Name the part you need. Then investigate the possibilities of Everdur!

At right—Riveted Everdur digester for process work—8′ in diameter. Everdur vessels of all types and sizes are put to endless uses.

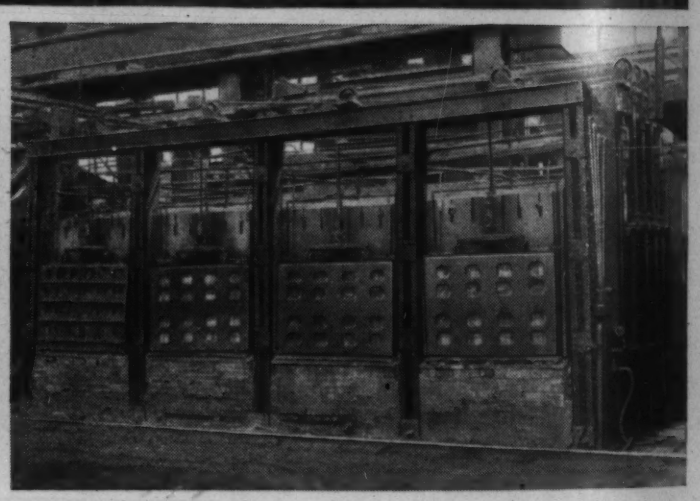
ANACONDA
from mine to consumer

THE
AMERICAN BRASS
COMPANY
General Offices: Waterbury, Conn.

ANACONDA COPPER & BRASS

FUEL SAVINGS
easily justified this installation

Recuperator Applied to Four-Door Reheating Furnace—Note "hot" fan handling air at 900° F.



Charging Side of Recuperative Four-Door Reheating Furnace

OF course you are interested in fuel savings. And so were the engineers in a Pittsburgh District Steel Plant.

For that very important reason they installed this Carborundum Company Recuperator—equipped with tubes of Carbofrax, the Carborundum Brand Silicon Carbide Refractory.

The recuperator applied to a four-door reheating furnace, preheats all their combustion air to about 900° F. for natural gas and oil fuel. In the furnace they handle miscellaneous sizes of billets with hot and cold charging on a solid hearth. They operate on a 24-hour schedule. The fuel savings effected more than justified the investment. Let us send you information on how to save fuel in your plant.

TUNE IN THE CARBORUNDUM BAND

Saturdays at 10 P. M. E. S. T
Columbia Chain

THE CARBORUNDUM COMPANY
REG. U. S. PAT. OFF.

RECUPERATOR

Equipped with "Carbofrax" Tubes
REG. U. S. PAT. OFF.

A Product of **THE CARBORUNDUM COMPANY** *Perth Amboy, N. J.*
(REFRACTORY DIVISION)

District Sales Branches: Boston, Chicago, Cleveland, Detroit, Philadelphia, Pittsburgh. Agents: L. F. McConnell, Birmingham, Ala.; Christy Firebrick Company, St. Louis; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle; Denver Fireclay Co., El Paso, Texas; Williams and Wilson, Ltd., Montreal, Toronto, Canada. (Carborundum and Carbofrax are registered trade-marks of The Carborundum Company.)

THIS new SC Standard Muffle Type Furnace for hardening high speed steels presents a modern appearance. It is one of the SC standard furnaces "dressed up" to meet the present day demands for improved appearances.

This furnace is just one of a complete line of SC standard furnaces—furnaces for any heat treating operation. Whether the operation requires high or low temperature, whether large or small oven, oil tempering or pot hardening . . . for high or low pressure . . . no matter what the heat treating or melting operation, there is a correct SC Standard Rated Furnace for the job. Write for catalog or other information.

Surface Combustion Corporation

SC TOLEDO, OHIO Sales and Engineering Service in Principal Cities

Also makers of.. ATMOSPHERE FURNACES . . . HARDENING, DRAWING, NORMALIZING
ANNEALING FURNACES . . . FOR CONTINUOUS OR BATCH OPERATION

TIMKEN Nickel-Moly Steels meet every carburizing steel requirement with consistently high factors of strength and wear resistance. They are especially valuable for highly-stressed parts such as automobile transmission gears, pinion gears and ring gears.

Timken Nickel-Moly Steels respond satisfactorily to simple carburizing and hardening processes, and show comparatively little distortion even when quenched direct from the carburizing medium. The distortion that does occur is so uniform that shop practices can be stabilized, and considerable piloting, lapping and grinding eliminated..

Additional economies are realized from smooth, easy machining, which reduces wastage and saves time and cutting tools. As pioneers in the development of nickel-molybdenum steels we are naturally in the best position to make their fullest advantages available to you. Our metallurgists will recommend the most suitable grade for your purpose.

THE TIMKEN STEEL & TUBE COMPANY, CANTON, OHIO

District Offices or Representation in the following cities: Detroit Chicago New York Los Angeles Boston Philadelphia Houston Buffalo Rochester Syracuse Tulsa Cleveland Erie

World's Largest Producer of Electric Furnace Steel

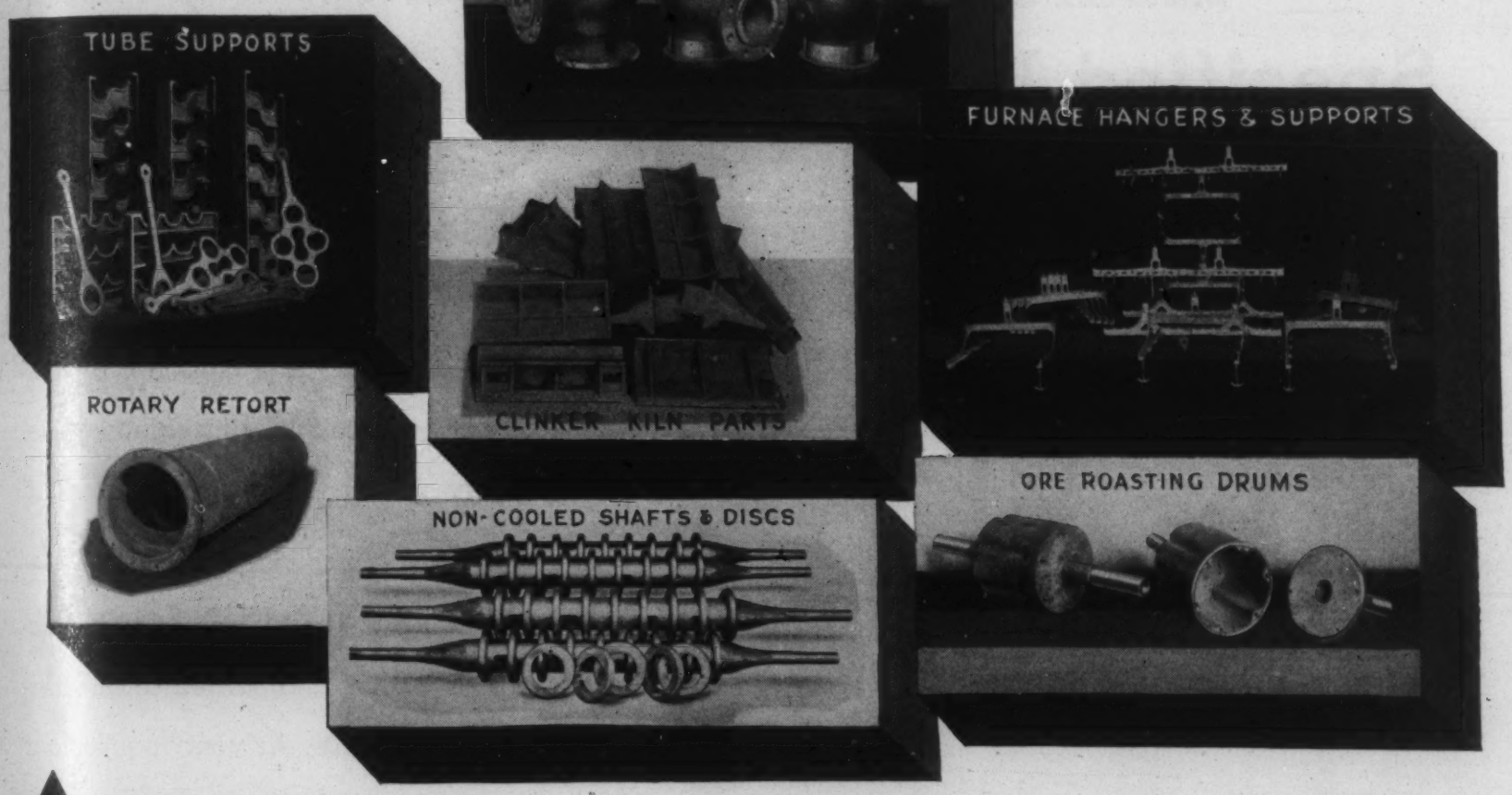
TIMKEN ALLOY STEELS

ELECTRIC FURNACE AND OPEN HEARTH • ALL STANDARD AND SPECIAL ANALYSES

AMSCO ALLOY

When correctly applied does not burn, crack, bend, warp or scale!

Resists corrosion, abrasion and heat to 2100° F!



AMSCO ALLOY IS NOT NEW!

AMSCO ALLOY is an old, time-tested series of chromium-nickel and iron alloys now standardized in six different analyses and sold under this new trade name.

Eight years of making and applying AMSCO ALLOY to hundreds of industrial uses requiring complete heat, corrosion and abrasion resistance provide us with an unsurpassed knowledge of the demands made on and the results obtained from these alloys.

Applications of cast parts resisting the corrosive action of gases, acids and mine water, etc., are many. Heat resisting applications in furnaces, ovens, hearths, pots, boxes, etc., are innumerable. Abrasion resisting applications such as rolling mill guides are frequently met.

You, too, can profit by using cast parts of AMSCO ALLOY on equipment and in processes where you must combat the ravages of heat—corrosion—and abrasion.

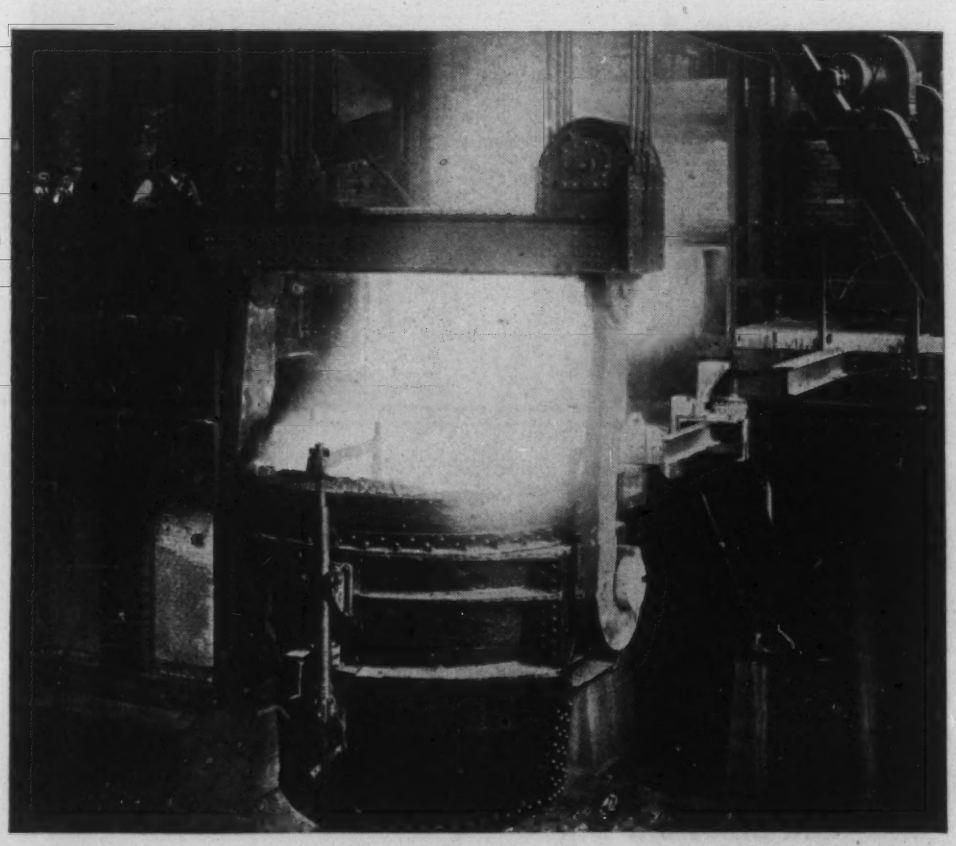
Let our engineers help you in designing your parts so as to secure maximum life. Let our sales engineers show you how you can profitably apply them to your work. Specify AMSCO ALLOY on every cast part requiring complete heat—corrosion—and abrasion resistance.

Send for a copy of the new Bulletin—AMSCO ALLOY.

AMERICAN MANGANESE STEEL CO.,
384 EAST 14TH STREET,
CHICAGO HEIGHTS, ILLINOIS.
Offices in Principal Cities.

AMSCO
TRADE MARK REGISTERED

DEOXIDATION with Silico-Manganese insures Specified Results



● The specified cleanliness of your finished steel is insured when Silico-Manganese is used to deoxidize the bath. Immediately upon its addition to the molten steel, Silico-Manganese melts and unites with the oxygen present to form manganese-silicate particles. These particles being large and of low specific gravity rise rapidly out of the bath into the slag. The speed with which this cleansing action is completed makes it possible to tap the steel within 10 to 15 minutes—thus allowing a close control of final analysis.

Silicon, manganese and carbon are present in exact quantities in Silico-Manganese. This assures uniform results, both chemical and physical, in any standard practice.

Electromet Silico-Manganese is manufactured in four grades and carried at all Electromet shipping points. At your request our engineers will be glad to study your practice and recommend the grade which will insure the best results.

CHROMIUM

High Carbon Ferrochrome (maximum 6% carbon)
Low-Carbon Ferrochrome (in grades, maximum 0.06% to maximum 2.00% carbon)
Chromium Metal
Chromium-Copper
Miscellaneous Chromium Alloys

▼

SILICON

Ferrosilicon 15% Ferrosilicon 50%
Ferrosilicon 75%
Ferrosilicon 80 to 85%
Ferrosilicon 90 to 95%
Refined Silicon
(minimum 97% Silicon)
Calcium Silicon
Calcium-Aluminum-Silicon
Calcium-Manganese-Silicon
Silicon-Copper
Miscellaneous Silicon Alloys

▼

BRIQUETS

(Patented)
Chrome Briquets Silicon Briquets
Manganese Briquets

TUNGSTEN

▼

MANGANESE

Standard Ferromanganese
78 to 82%
Low-Carbon Ferromanganese
Medium-Carbon Ferromanganese
Manganese Metal
Manganese-Copper
Miscellaneous Manganese Alloys
Spiegeleisen

▼

SILICO-MANGANESE

All grades including Silico-Spiegel

▼

VANADIUM

All Grades

▼

ZIRCONIUM

Aluminum-Zirconium
35 to 40% Zirconium
12 to 15% Zirconium
Zirconium-Manganese-Silicon

PRODUCT OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide and Carbon Corporation
UCC
Carbide and Carbon Building,
30 East 42nd Street, New York, N. Y.

Electromet Ferro-Alloys & Metals

Tribute to a Great American

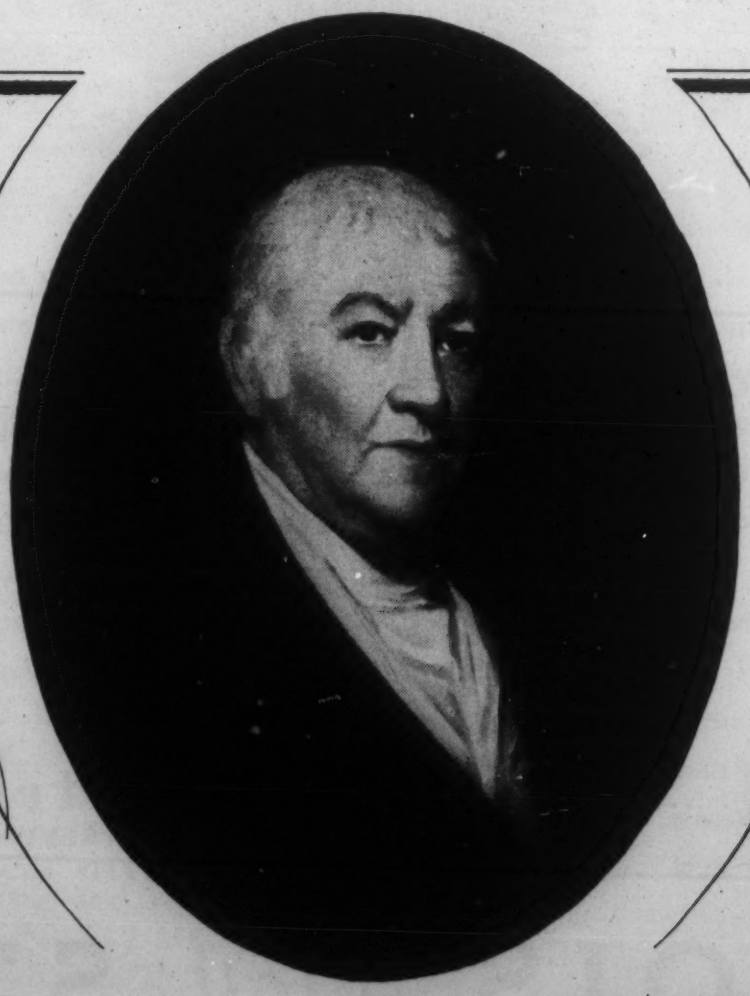
On December 22, 1800, Paul Revere wrote to a friend: "I have engaged to Build me a Mill for rolling Copper into Sheets, which for me is a very Great Undertaking, and will require every Farthing which I can Rake or Scrape."

The mill was built . . . and Revere's copper was soon the standard of the Colonies. His copper was used to roof many important buildings; his bells sounded from sixty churches throughout New England; and his spikes, bolts, and copper sheathing were used for the new fleet of frigates . . . headed by the famous "Old Ironsides."

Looking back over these Colonial days, Revere Copper and Brass Incorporated recognizes that it owes more to the illustrious "midnight rider" than the fact that he founded the present company. For Revere was great, not only as a patriot, but as the foremost industrial pioneer. He tirelessly sought to do things in new and better ways. And as an artist and craftsman, he insisted on fine materials and painstaking workmanship.

It is this spirit, maintained through one hundred and thirty-four years of growth and consolidation, that is this company's proudest possession.

Paul Revere

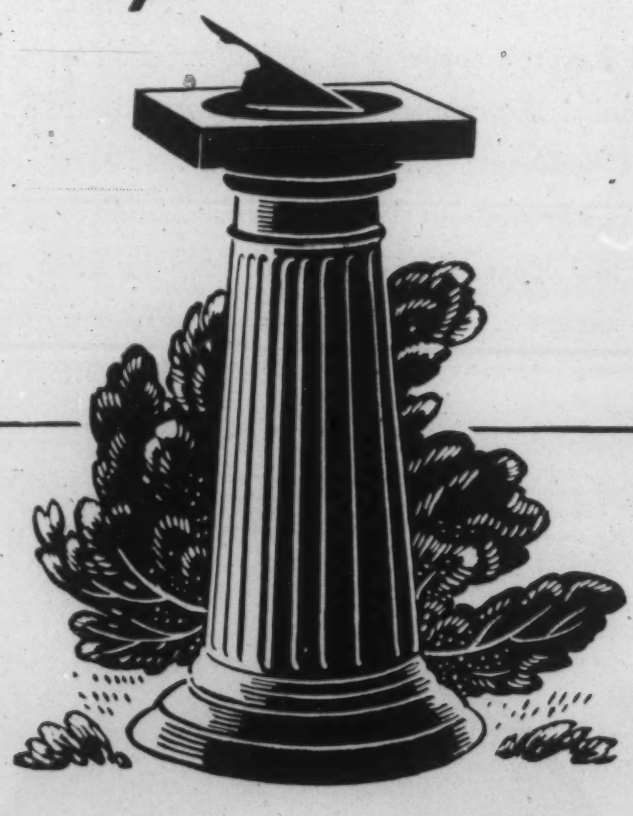


REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere

TIME WILL TELL

but may tell too late



TODAY'S mistakes will be shown up by tomorrow's business. But tomorrow may be too late.

As production costs creep up, improvements in methods and in production equipment are not always enough. A re-appraisal of materials may spell the difference between profit or loss for 1935.

Nowhere is this more true than in your choice of steels. Machining costs that are too high may often be reduced by a change in steel specifications without spending a single dollar on new equipment. Rejections or wastes in production may often be reduced by switching steels or altering heat treatment. A new steel in a given part may increase the quality and salability of your product at no increase in cost.

Never has judicious selection of the right steel for a job been of greater importance than today. To aid you in that selection, our metallurgists are prepared to analyze your requirements and specify for you the steel which provides the necessary physical requirements at the lowest cost per ton in price and in production in your plant. Their assistance involves no obligation on your part.

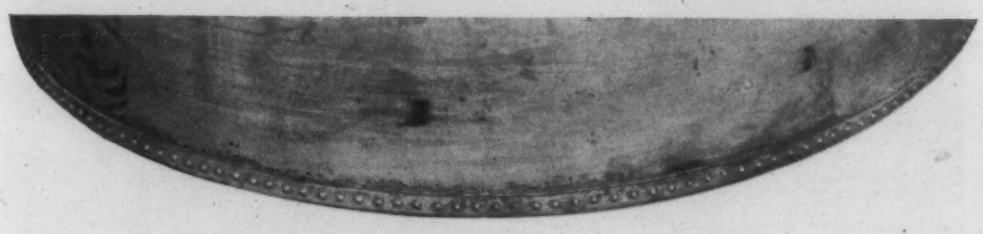
Illinois Steel Company
208 SOUTH LA SALLE STREET • • CHICAGO, ILLINOIS
SUBSIDIARY OF UNITED STATES STEEL CORPORATION

ILLINOIS *alloy* STEELS

ALWAYS DEPENDABLE

These TANKS, made of 3/16" half hard c.r. copper, have an outside diameter of 92" and an inside depth of 72". They have been in service in a chemical plant for some time and the user reports they are "standing up fine."

For sound copper tanks . . .



These tanks, made by L. O. Koven & Brothers, Inc., Jersey City, N. J., are good examples of sound copper tank construction.

Service conditions called for resistance to heat and corrosion. Soft solders were not suitable, but SIL-FOS Brazing Alloy solved the problem.

A thin ribbon of SIL-FOS Brazing Alloy was inserted between the overlapping tank seams. Then the seams were riveted together. When heat was applied, SIL-FOS, flowing freely at 1300° F., alloyed with the copper, joining the sheets into one solid unit. In this instance, no flux was necessary—the self-fluxing action of SIL-FOS being sufficient to join the copper to copper.

SIL-FOS is ideal for making joints like this. It withstands heat and resists corrosion to the same extent as the metal itself. It is equally effective, when used with a flux, for joining brass, bronze, extruded bronze and other non-ferrous metals and alloys. It works fast, penetrates deeply, makes joints as strong as the metals joined, with savings in time, labor and material. For proof—TRY SIL-FOS on your work.

Write for details and a copy of
BULLETIN 512-MA

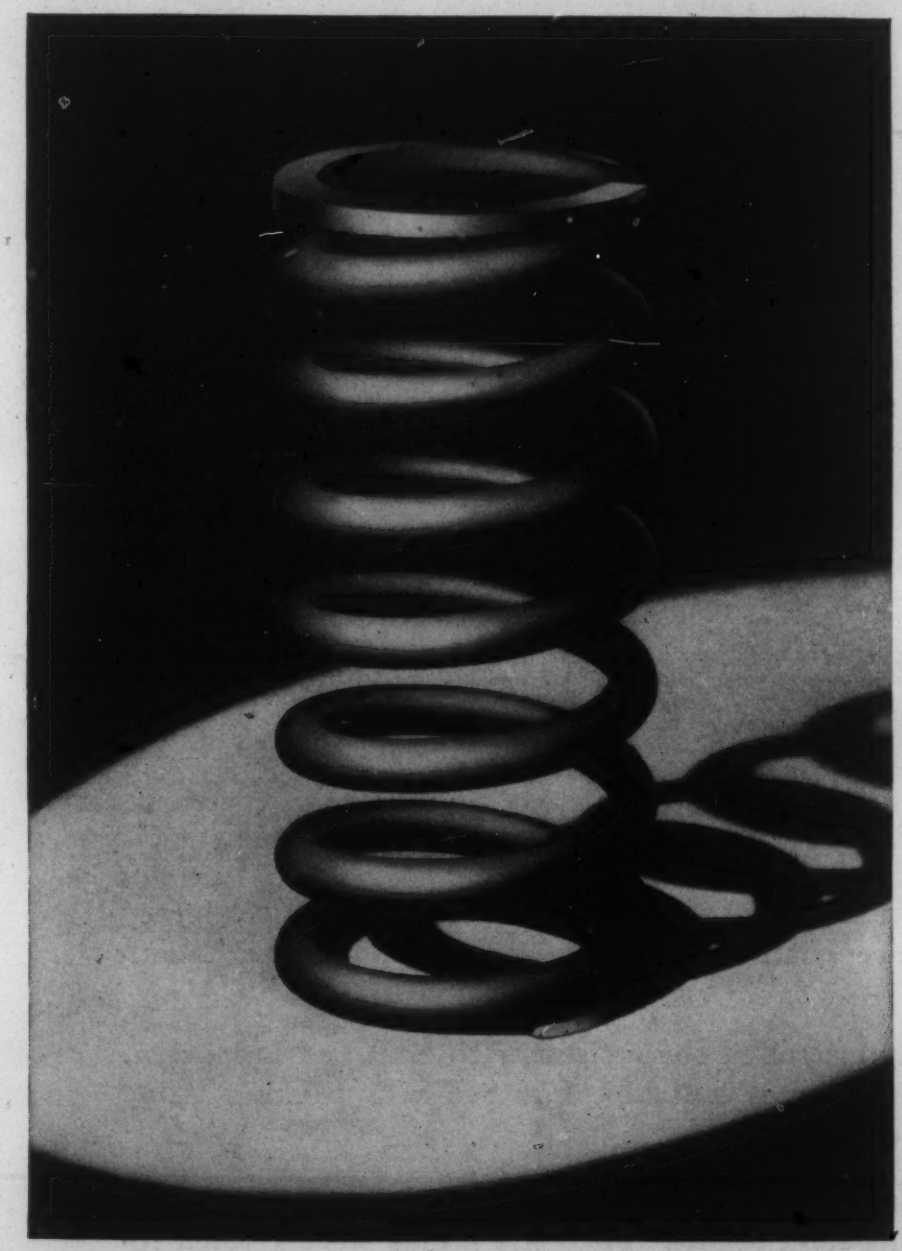
TRY Sil-Fos BRAZING ALLOY

SIL-FOS can be obtained from all distributing stations of the AIR REDUCTION SALES COMPANY in the United States, as well as from many prominent supply houses.

HANDY AND HARMAN 82 Fulton St., New York

In Selecting A Steel For Coil Springs,

Bear In Mind –



The problem in selecting a steel is to choose one that will enable the manufacturer to duplicate the results desired thousands and thousands of times with regularity and a minimum of effort and cost.

Its demonstrated melt to melt uniformity and its conceded freedom from sensitivity make Silicon-Vanadium the ideal analysis for coil springs of many types.

Metallurgists of the Vanadium Corporation, familiar with the difficulties of spring design and manufacture, will be glad to co-operate with you.

VANCORAM BRAND

FERRO-ALLOYS
of vanadium, silicon, chromium, titanium, and silico-manganese, produced by the Vanadium Corporation of America, are used by steel makers in the production of high-quality steels.

VANADIUM CORPORATION OF AMERICA
120 BROADWAY, NEW YORK, N.Y.

CHICAGO — PITTSBURGH *Bridgeville, Pa.* — DETROIT

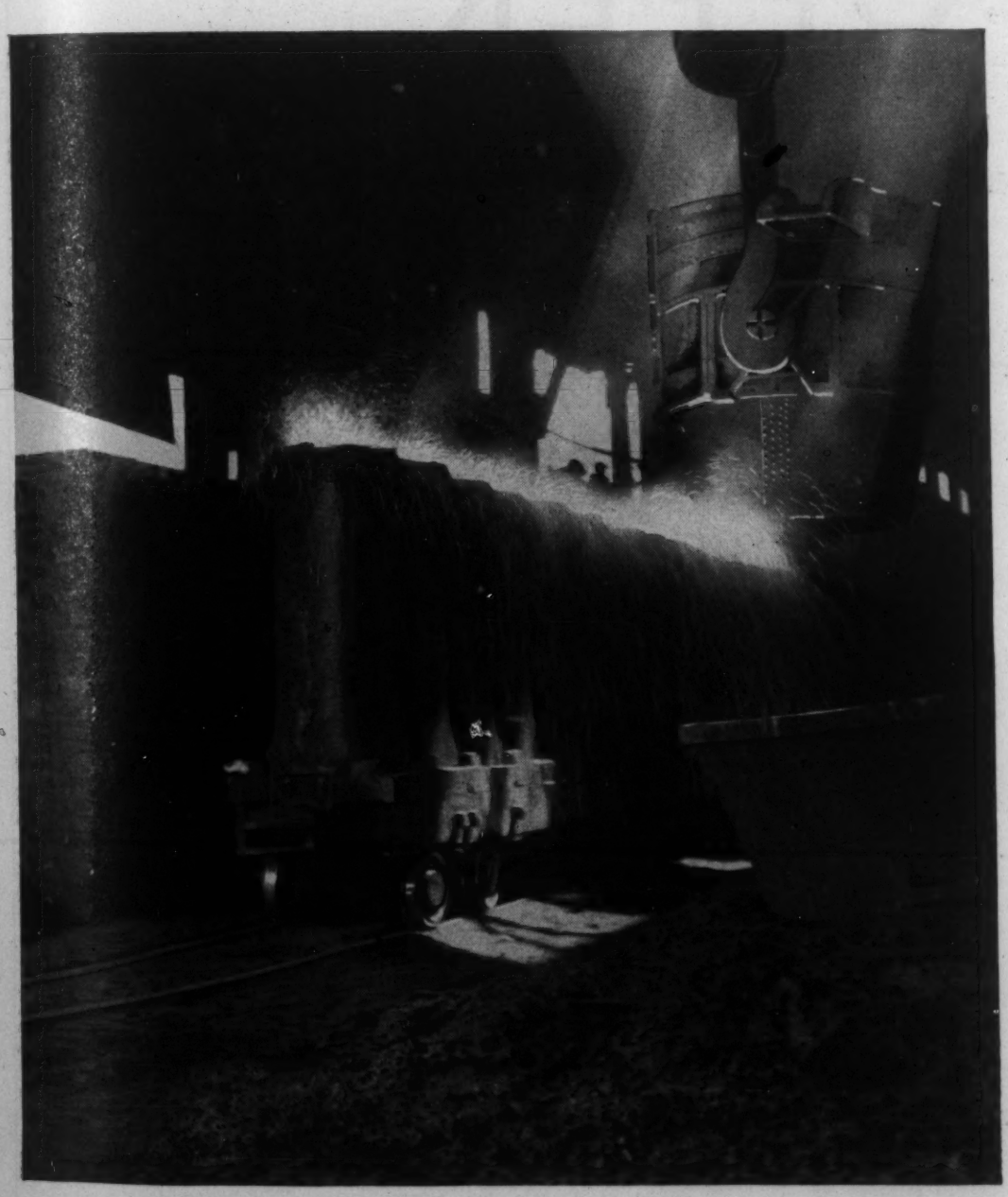
Plants at Bridgeville, Pa., and Niagara Falls, N.Y.
Research and Development Laboratories, Bridgeville, Pa.

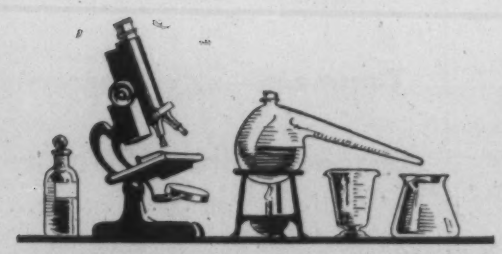
VANADIUM STEELS

for strength, toughness and durability

Pedigreed Forgings

Countless experiments, trial and error, exacting selection and years of patient, painstaking study and research have been required to bring to the present high standards of perfection our modern industrial developments in product and method. • In every instance the sought for result is improved, outstanding performance. So it is with a forging. It, too, must have blood lines. These are not only the good name, skill and workmanship of the forge shop, but equally important, the forging billet which is converted into the finished forging. • When you use ASCO Special High Grade Forging Billets and Slabs you are sure of the pedigree of your forgings—there need be no doubt in your mind as to quality and performance—these characteristics are unmistakably present in every ASCO billet.





Our Metallurgical Laboratories are at your service in developing special steels for special purposes.

ASCO FORGING BILLETS

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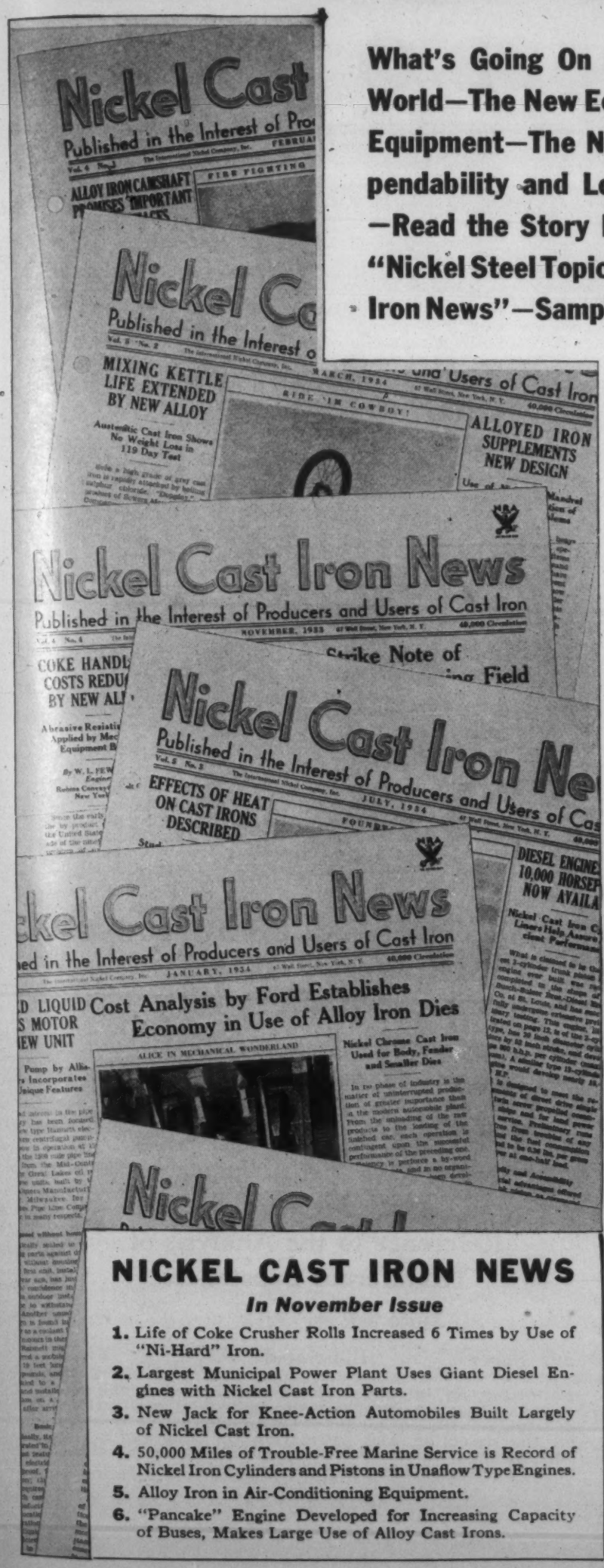
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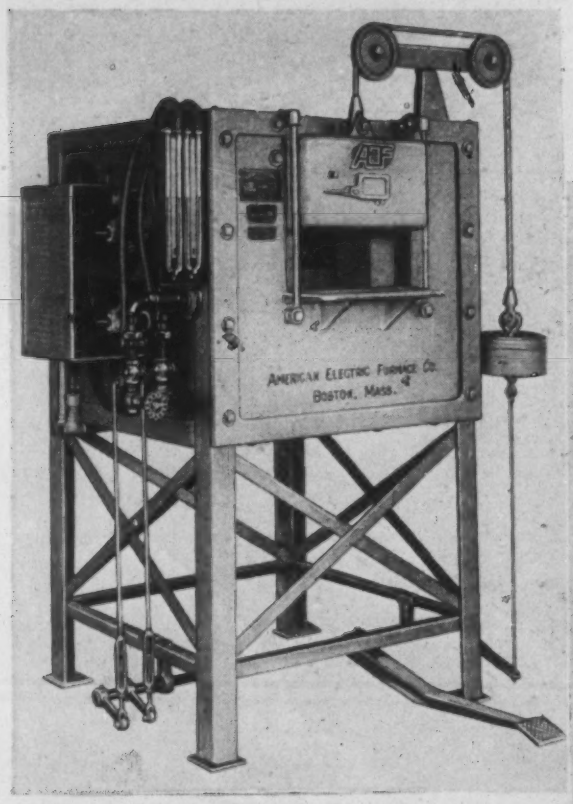

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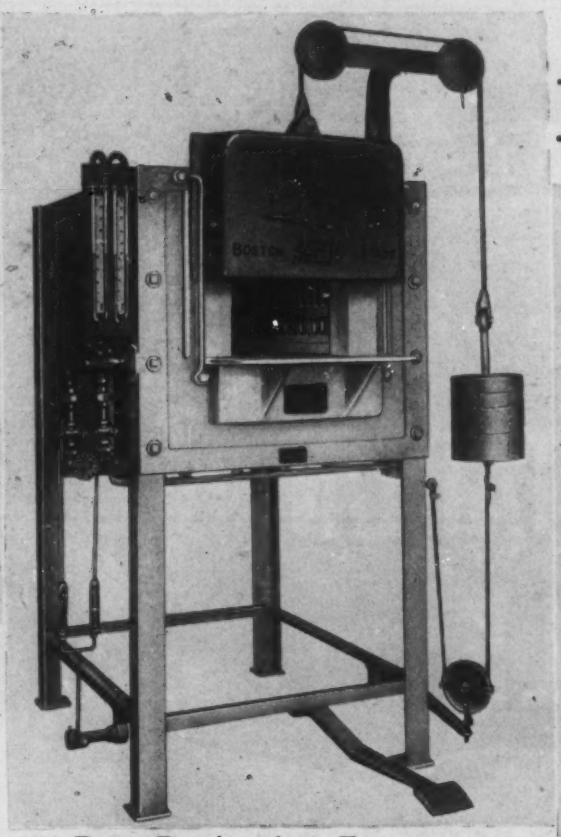

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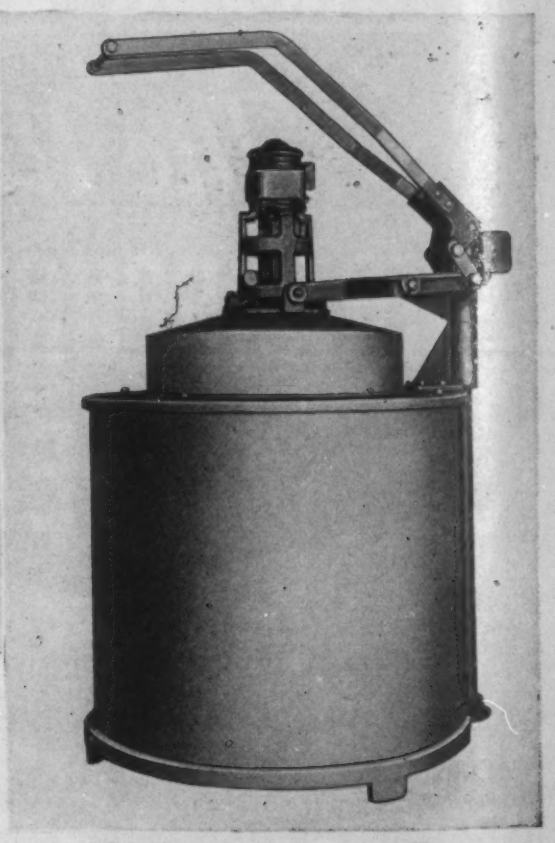

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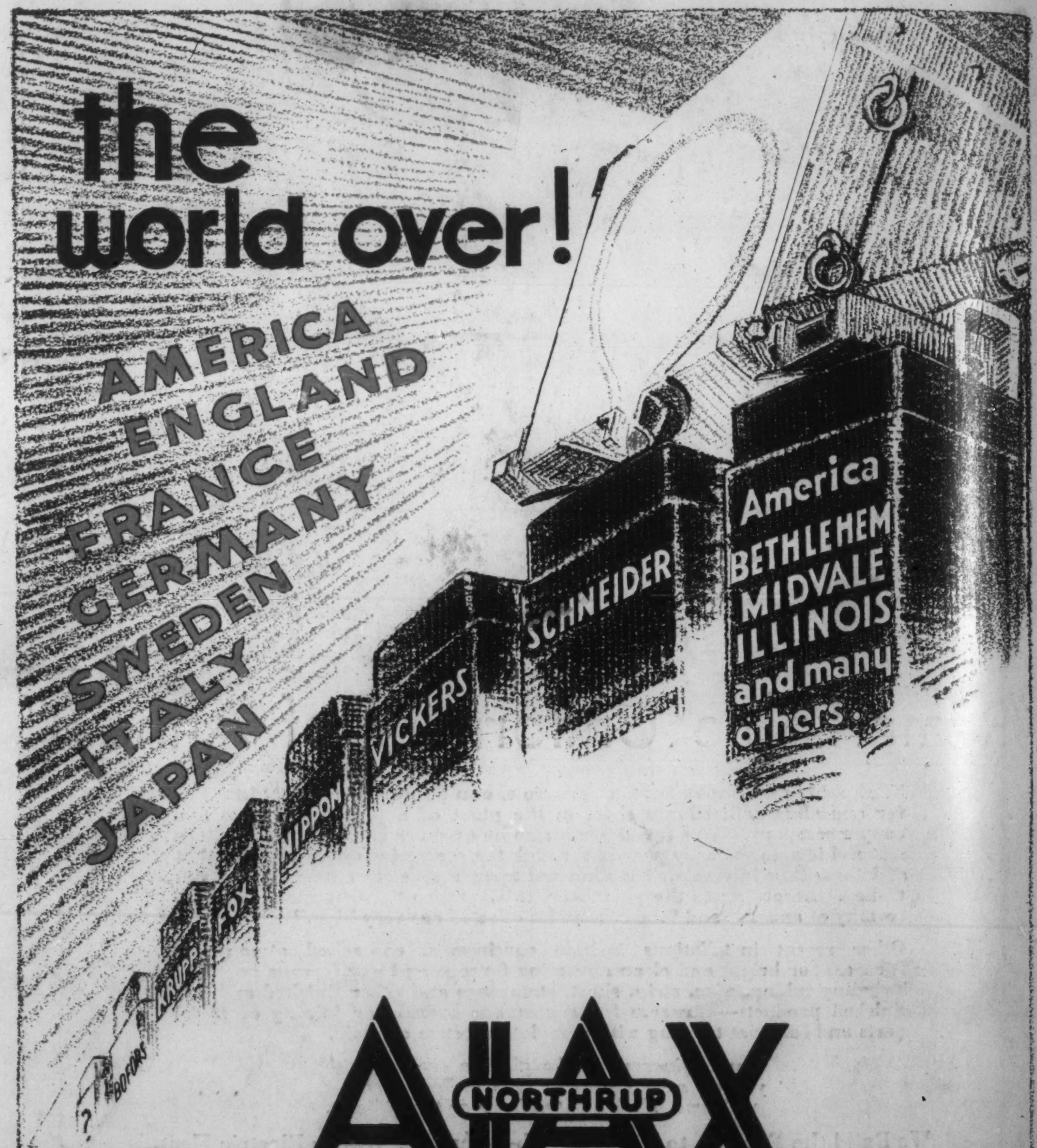

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